MACHINERY.

Vol. 6. July, 1900. No. 11.

TESTING THE STRENGTH OF MATERIALS.—4.

TENSION TESTS CONTINUED, WITH A DESCRIPTION OF THE EMERY TESTING MACHINE.

EDWARD F. MILLER.

Fig. 1 gives a general view of a 300,000 pound Emery testing machine built by Wm. Sellers & Co., for the Massachusetts Institute of Technology. The machine can test in compression specimens up to 18 feet in length and in tension up to 13 feet. The maximum travel of the loading piston is 42"; the maximum rate of speed of the loading piston is 4½" per minute. The straining cylinder is at the right end of the cut, the weighing head at the left end. Both of these castings are supported by, but not fastened to, a steel frame which forms the bed of the machine.

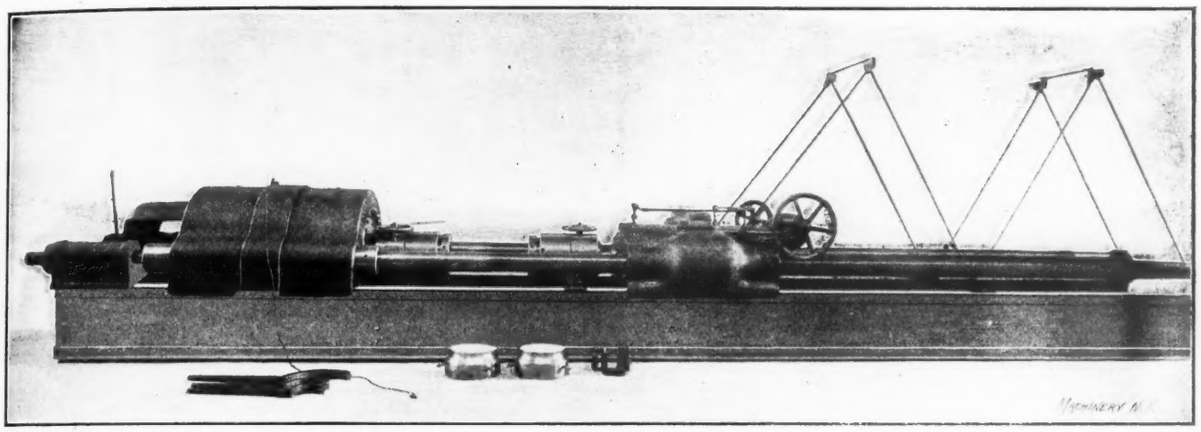

Fig. 1. General View of Emery Testing Machine.

Two steel screws 7" in diameter run the entire length of the machine. They are threaded for a length of about 19 feet. They pass through the weighing head and are securely fastened to it by steel nuts. Castings through which the screws can slide support the right hand end of the screws.

Two cylinders containing buffer springs are bolted to the left hand end of the frame. These springs push on the end of the steel screws.

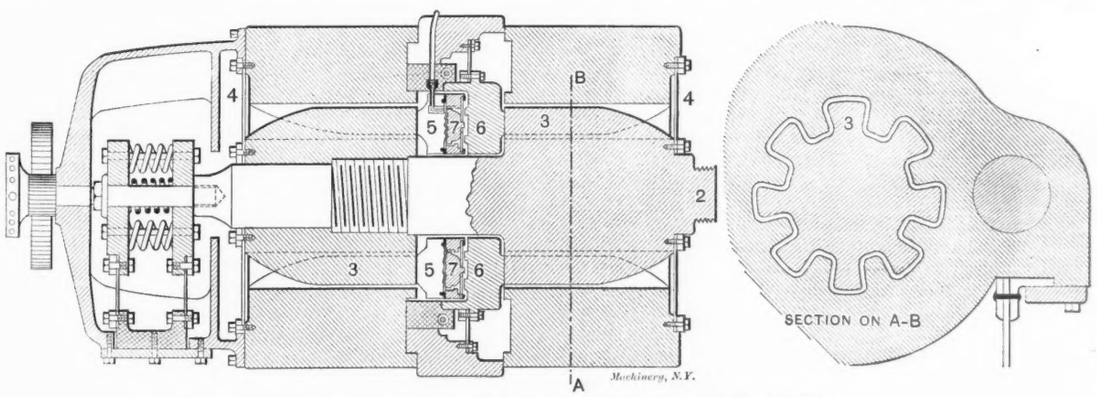

Fig. 2. Section through the Weighing Head of the Emery Testing Machine.

When a tension specimen breaks suddenly, the straining cylinder recoils to the right and the weighing head and screws recoil to the left; in this way the buffer springs get an additional load at each recoil, till finally they are compressed sufficiently to be able to start the weighing head to the right. Once started, the head moves back to its original position. The 7" steel screws have to carry whatever load may be put on the specimen. If the specimen is in tension, the screws are under compression and vice versa.

The Straining Cylinder.

The straining cylinder is a closed hydraulic cylinder with piston and piston rod packed with cup-shaped leather packing rings. The cylinder is entirely filled with oil, which is supplied and exhausted through the jointed folding pipe seen at the right of Fig. 1. If the machine is working in tension, the oil under pressure enters at the left hand end of the cylinder and an amount of oil equal to that entering is driven out of the other end of the cylinder, back through one set of the folding pipes to the suction chamber of the power pump which forces the oil.

The straining cylinder may be moved along the bed to such positions as the different lengths of test pieces may necessitate. This is accomplished by rotating two large nuts on the 7" steel screws, these nuts turning inside the enlargements seen on the sides of the casting Fig. 1. The nuts are 4" narrower than the width of the recess in which they turn, thus allowing for the recoil already spoken of. After moving the straining head to a new position on the screws the nuts must be brought up against the proper bearing side of the recess. For tension work the nuts should be against the right hand side of the recess, and unless this is looked to very carefully the machine may be injured. While moving the straining head the nuts are driven by pinions engaging with spur gears on the outside of the nuts and the pinion shafts are in turn driven through sets of bevel gears by a shaft turned by a rope wheel. An epicyclic train of gears, serving as differential gears, is introduced in this driving mechanism, the

object being to keep the resistance offered by the two nuts the same. If, for any reason, one nut should advance faster than the other, due perhaps to a slight difference in the pitch of the two screws, that nut, on account of the added work, would turn harder than the other nut. The differential motion now operates and causes the nut moving with the less resistance to turn at a greater speed till it catches up with the other.

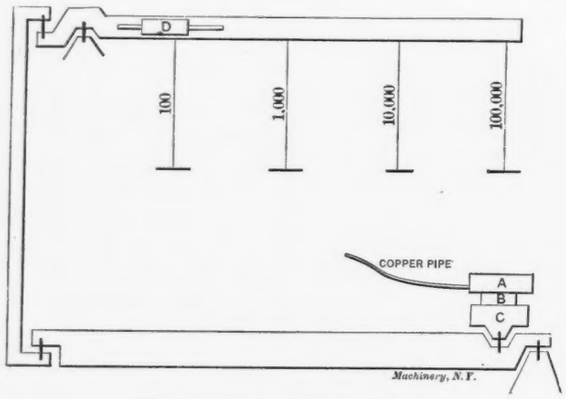

Fig. 3 A. Detail of Weighing Device.

Weighing Head.

A longitudinal section through the weighing head is shown by Fig. 2. Any load applied by the straining cylinder is transmitted through the specimen to a draw bar marked 2 at the weighing end of the machine. Fastened to the draw bar there are two fluted steel pistons marked 3, 3. This bar with pistons is held in place by annular flat steel discs ⅛ of an inch thick. These discs

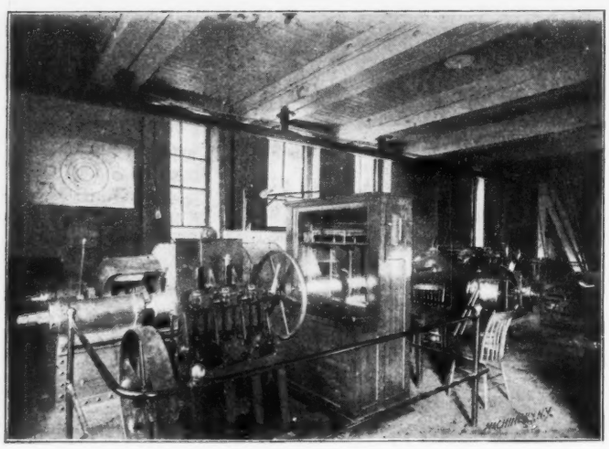

Fig. 4. Hydraulic Pump and Scale.

marked 4, 4, hold the bar suspended inside the outer casting. Between the pistons there are three castings, 5, 6, 7, connected, as shown in the drawing. The outer of these is supported by flat springs attached to the main casting. The thickness of these three castings is a trifle less than the distance between the bearing surfaces of the outer castings. Between two of these castings there is an outer diaphragm of brass .018" thick. This brass is spun into recesses, as shown in the drawing. A space of 1-32" wide between the two sides of the diaphragm is filled with a mixture of glycerine and alcohol. The diaphragm is connected with the weighing mechanism in the scale case by a small copper pipe having a hole about 1-20" in diameter. At the left hand end of the draw-bar there are five springs under compression. By means of the hand wheel at the extreme left, the force of these springs can be taken as a push, or as a pull, on the draw-bar. These springs exert force enough to more than overcome the

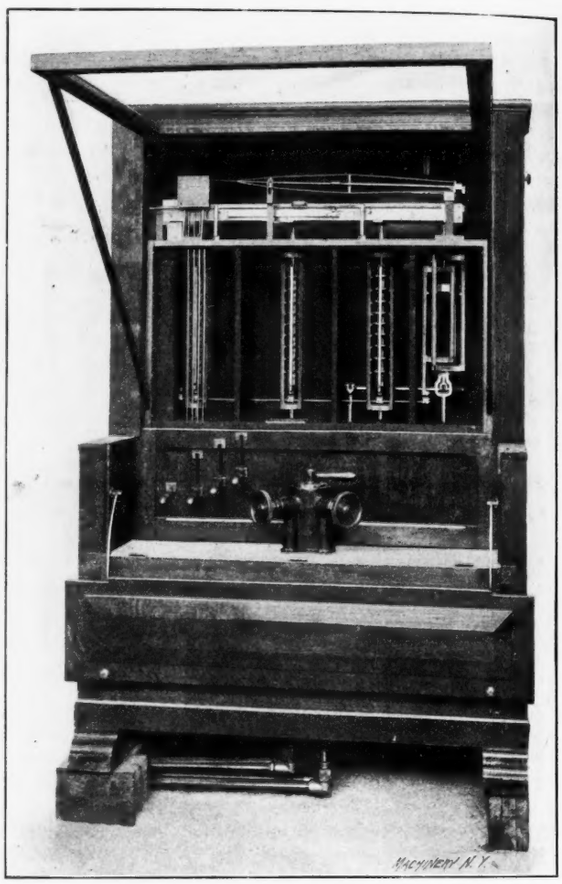

Fig. 3 B. Scale Case and Operating Valve.

resistance to bending offered by the steel discs supporting the draw-bar. Suppose the machine is to be used for compression work. The hand wheel is turned so as to cause the five springs to exert a pull on the draw-bar. As a result, the draw-bar moves to the left a very small distance. As it moves the right hand piston on the draw-bar pushes the castings holding the diaphragm to the left till the left-hand one brings up on the bearing surface of the outer casting. The extra force of the springs causes a slight squeeze to be given the liquid inside the diaphragm. This

Compression of Spruce Column.

Weight	Gauge Length.	Size of Column. Length.		Width.	Depth.	Sectional Area	Ratio of length to least side.	Ultimate Strength. Actual.	Lbs. per sq. in.	Ratio of Stress to Strain, commonly called modulus of elasticity.	Remarks.
Lbs.	In.	Ft.	In.	In.	In.	Sq. in.					
226	100	17	.0	8.00	8.00	64.00	25.50	155,000	2,422	1,297,800	Deflected diagonally.
276	"	18	.0	8.25	8.06	66.52	26.79	140,000	2,105	1,385,600	" " "
357	"	16	.0	10.00	10.00	100.00	23.00	274,000	2,745	1,656,300	" " Crushed 5 feet from platform.
337	"	15	.0	10.00	10.00	100.00	18.00	261,300	2,613	1,552,800	" downward. " at center.
162	"	11	1.00	8.13	8.13	66.02	16.37	180,000	2,727	1,405,200	" diagonally. " 4½ feet from platform.
188	"	9	10.75	8.00	12 13	97.00	14.81	191,000	1,969	1,009,200	" horizontally. " 1′ 3″ from respective ends.
182	"	9	7.88	7 88	12.00	94.50	14.71	188,500	1,995	982,540	" downward. " at knot 18″ from end.
126	50	9	0.13	8.13	8.13	66.02	13.31	191,500	2,901	1,439,900	Crushed 1′ from platform.
100	"	7	6.00	8.13	8.13	66.02	11.07	170,800	2,507	1,442,700	" 6″ " "
133	"	9	6.38	8.13	8.13	66.02	14.45	175,700	2,662	1,357,300	" 3′ " "
66	"	7	8.38	7.75	7.75	60.06	8.82	191,900	3,195	1,222,400	" 1.5′ " "
66.5	"	5	9.75	7.88	7.88	61.03	9.00	156,000	2,556	834,270	" " " "
204	"	7	11.00	8.25	8.25	67.03	11.69	175,400	2,617	857,380	" " " "
200	100	9	10.25	10.13	10.13	102.62	11.67	182,800	1,784	884,000	Deflected horizontally. Crushed at end. Part of column tested December 8, 1894.
...	100	12	00.00	10.00	10.00	100.00	14.40	190,000	1,900	1,180,000	Deflected diagonally. Crushed at center.
...	...	12	00.00	10.00	10.00	100.00	14.40	192,000	1,920	.....	Crushed near one end.

increased pressure is transmitted through the copper pipe to the scale case.

In the scale case, Fig. 3A, there is an inverted steel cup A, having a brass diaphragm on its lower face. This cup connects through the copper pipe with the annular diaphragm already described. Pressure on the diaphragm is transmitted through the pieces B and C to the lever system, where it may be weighed by putting weights in the different scale pans. The initial load put on by the extra force of the five springs is counter-balanced by moving the balance weight D to the right. The knife edges used in the lever system are thin pieces of steel, driven into slots cut into the levers. The machine has to be rated, when made, by comparing it with a sensitive lever machine made specially for this use.

Fig. 3B shows the scale case and operating valve. Fig. 4 shows the location of the hydraulic pump with reference to the scale case. The hydraulic pump is operated through a link and link block, the position of which can be varied at will by turning the hand wheel. The amount of oil pumped can be adjusted in this way or it can be controlled by the regulating valve at the scale case. The two valves with circular handles are needle valves, the right hand one admitting oil from the pump to the valve chamber and the left hand valve serving as a leak valve. Inside the valve chamber there are three ports in a horizontal seat, the right hand port leading to the tension end of the straining cylinder, the left hand port to the compression end of the cylinder and the center port to the overflow tank at the suction of the pump. The horizontal handle at the top moves a cup-shaped valve which may be made to connect either port with the center port, and is kept on its seat by the pressure of the oil. If the handle is turned so as to uncover the right hand port and to connect the center and left hand port, the oil under pressure enters the tension side of the straining cylinder and the oil driven out in front of the piston is returned underneath this little valve to the pump.

Fig. 3B also shows the method of weighing the load. The weights are gold-plated discs carried in cages moved by four handles. Suspended from the weighing beam are four cages similar to the others but with lugs spaced in such a way that if the cage moved by a handle is raised one notch, one disc is transferred from the handle cage to the beam cage. At the same time the motion of the handle indicates, through figures at the end of the indicator needle, the number of weights on the beam.

Assuming the extreme motion of the indicator needle to be 2", the motion of the draw-bar 2, 3, 3, calculated from the ratio of the hydraulic chambers and the multiplication of the levers figures somewhere about 1-150,000 of an inch. The motion is actually greater than this.

There is but little transfer of liquid from the diaphragm to the scale case and if the indicator needle is kept from vibrating, there is no error introduced into the weighing by the stiffness of the steel knife edges or by the steel discs 4, 4.

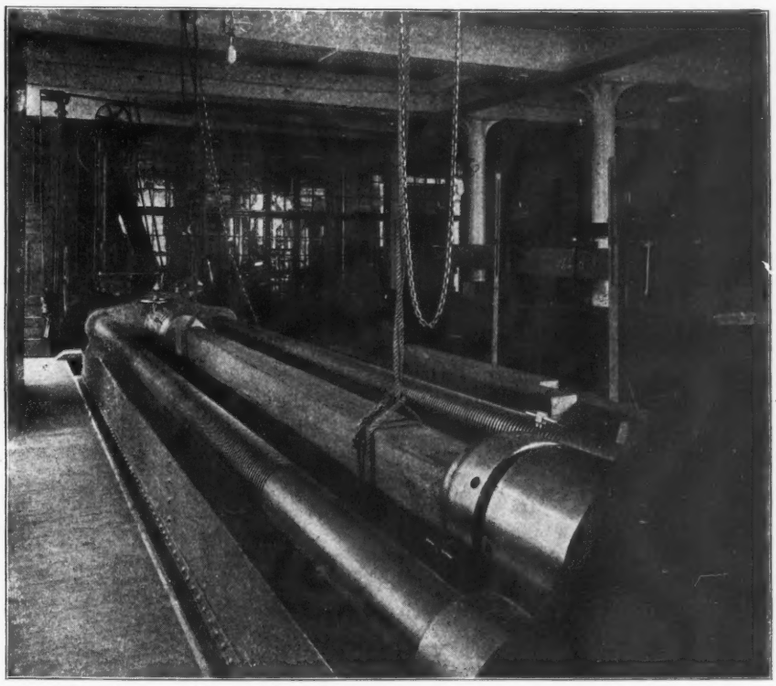

Fig. 5. Testing Machine, as located in the Laboratory.

Fig. 5 shows the machine as installed at the Engineering Laboratories Massachusetts Institute of Technology.

It may be of interest to quote here one of the many sets of tests made on this machine by the students at the Massachusetts Institute of Technology as a part of their regular laboratory work.

Tests of Wooden Columns.

Kind.	Weight.	Gauge Length	Size of Column. Length.	Width.	Depth.	Sectional Area.	Ratio of length to least side.	Ultimate Strength. Actual.	Pounds per sq. in.	Ratio of Stress to Strain, commonly called modulus of elasticity.	Remarks.
	Lbs.	In.	Ft. In.	In.	In.	Sq. In.					
Yellow Pine	230	100	13 6.38	8.13	8.13	66.10	19.96	289,000	4,380	1,468,000	Deflected Diagonally. Crushed at center.
Yellow Pine	...	100	10 7.25	7.75	7.75	56.36	16.48	153,700	2,730	1,079,000	Crushed at knot at middle.
Yellow Pine	...	...	10 7.25	7.75	7.75	56.36	16.48	180,000	3,190	.....	" 1 ft. from end.
Yellow Pine	217	100	10 7.25	7.75	7.75	56.36	16.48	210,900	3,740	1,893,000	" at center.
Yellow Pine	174	100	10 7.25	7.75	7.75	56.36	16.48	217,000	3,850	1,568,000	" at center.
Oak . . .	240	50	8 4.00	8.00	10.38	83.04	12.50	159,400	1,921	994,000	Tested with oak bolster. Failed by splitting and crushing at end next to bolster.
Oak . . .	130	50	4 6.25	8.00	10.25	82.00	6.78	156,000	1,902	1,575,000	Tested with oak bolster. Failed by splitting at end next to bolster.
Spruce . .	85	50	5 0.50	9.50	9.88	93.86	6.37	166,000	1,770	1,082,000	Tested with oak bolster. Failed by splitting at end next to bolster.
Spruce . .	125	50	7 2.25	7.50	12.00	90.00	11.50	169,600	1,900	1,812,000	Tested with oak bolster. Failed by splitting at end next to bolster.
Spruce . .	88	50	5 5.69	9.50	9.88	93.86	6.91	198,000	2,110	1,316,000	Tested with maple bolster. Failed by splitting at end next to bolster.
Spruce . .	88	50	5 6.00	9.75	9.75	95.06	6.77	250,000	2,730	1,154,000	Tested with maple bolster. Failed by splitting at end next to bolster.
Oak . . .	151	50	4 6.75	4.75	7.75	36.81	11.53	170,300	1,870	884,000	Tested with oak bolster. Failed by crushing and splitting column at end next to bolster.
Spruce . .	183	100	11 0.00	9.50	9.63	91.49	13.89	143,000	1,560	1,443,000	Tested with oak bolster. Failed by splitting at end next to bolster.
Spruce . .	183	100	9 9.50	9.50	9.50	90.25	12.37	153,600	1,700	1,526,000	Tested with oak bolster. Failed by splitting at end next to bolster.
Spruce . .	275	100	11 11.50	10.00	10.00	100.00	14.35	138,000	1,380	889 700	Tested with oak bolster. Failed by splitting at end next to bolster.
Spruce . .	260	100	11 5.75	10 13	10.13	102 62	13.60	145,000	1,410	1,001,000	Tested with yellow pine bolster. Failed by splitting and crushing at end next to bolster.

These columns planed and bored through center. 2" hole.

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The highest artificial heat yet produced is that obtained by the electric furnace and is supposed to have been between 6,500 and 6,700 degrees Fahrenheit. It should be understood that the electric furnace is simply an electric arc inclosed within a closed crucible of incombustible material such as graphite or fire-clay.

1. Facade of the United States Section of the Department of Mines and Metallurgy.
2. Textile Machinery in the French Section, with Electric Crane.
3. French Internal Combustion Engines.
4. French Hydraulic Machinery with Belts of Various Materials in the Balcony.
5. Swiss Hydraulic and Electric Machinery.
6. Portable Traveling Crane, with Base of Power Plant Chimney in the Background.

VIEWS OF MACHINERY EXHIBITS AT THE PARIS EXPOSITION.

MACHINERY AT THE PARIS EXPOSITION.

THE NEW SYSTEM OF GROUPING—BRIEF NOTES ABOUT THE DIFFERENT CLASSES OF MACHINERY.

ANDREW D. FULLER.

In former exhibitions the machinery has generally been grouped in one large pavilion of machinery. This grouping, although convenient for the study of machinery as a whole, has not afforded the opportunity for the appreciation of the very remarkable improvement of machinery in relation to the mechanical work of the great industrial establishments, and the betterment of their products found in the Exposition of 1900. On every hand throughout the entire extent of the main grounds, as well as at the Vincennes annex, are found interesting exhibits of machinery side by side with their products. The principal showing is made in the Champ de Mars section, in the succession of pavilions on the north and south sides having as a center the immense electrical display on the western end. There the latest and best efforts of France and the foreign countries are displayed. A large space in this building is given over to the United States for the display of electrical apparatus and accessories, while the main American machines are located in a special building at Vincennes.

In all departments there are excellent working models varying in scale from the actual size for machines of considerable dimensions to less than a half inch to the foot where whole industrial plants with all the details are accurately reproduced. In the mining section there are some of especial merit. There is found the steam plant with its battery of boilers adjacent to the powerful engines for pumping air and water or generating electricity; the hoisting engines, correct even to the materials of the cables used; the elevators carrying three and four tiers of cars laden with ore from deep shafts shown in the large drawings hung about the exhibits. These miniature cars are discharged on the proper tracks for conveying the ore to the crusher, where it is dumped automatically, crushed, sorted and carried to the proper bins. There are a number of full sized coal veins with their customary bracing, tracks, cars and hoisting apparatus.

On either hand are the iron ore and the method of its extraction and smelting, the machines for working the iron and a model of a steel frame building. One of these machines of especial interest, a 5,000 H. P. reversible three-cylinder rolling engine, making 160 revolutions per minute, built by Ehrhardt & Sehmer, Germany, for the Imperial Steel Works of Japan at Yawatamura, will be shipped after the Exposition. This is the smallest of thirty-one of this type built by them.

Fig. 1 shows the solid electro-bronze and marble facade of the United States section in the Department of Mines and Metallurgy. This is one of the handsomest facades in the Exposition.

The ground floor of the building devoted to threads and fabrics is chiefly occupied by machinery used in the textile industry. Spinning, weaving, printing and winding machines are in daily operation. Several interesting hand looms and a hand embroidering machine have attracted considerable attention. The German exhibits in this section, as well as in many others, are especially worthy of mention. In the French section is a machine for winding rubber with cotton or silk, to make the thread used in weaving elastic bandages. This is ingeniously constructed in duplicate to be operated by hand or a motor and is capable of extension for an indefinite number of spools. On the uppermost horizontal support turns the spool, bearing the rubber thread, which then passes through two sets of horizontal rollers, one set immediately below the spool and the other set on a horizontal support below the spools bearing the exterior covering. These rollers hold the thread with sufficient firmness to maintain the initial tension necessary to cause the thread to contract after winding and thus produce a firm covering. The rubber thread is fed through the vertical axes of the two spools carrying the silk or cotton, situated between the horizontal rollers, the upper turning right-handed for the first winding, the other turning left-handed for the second winding, to the revolving receiving cans below. The whole is cleverly arranged to be easily worked by one belt.

Fig. 2 shows some of the textile machinery in the French section, also an electric crane for unloading the exhibits from the cars below to the balcony level.

Fig. 3 shows a portion of the French vapor engine exhibits. The great enthusiasm displayed by the French for motor vehicles has aroused a lively interest in vapor engines. Those shown in the photograph are principally stationary engines, ranging from 1½ to 100 H. P.; the principal improvements noticeable being an economical increase of motive power. The smaller portable motors are exhibited in the adjoining space to the right of the picture. There are many electrical vehicles in use, but the vapor motors are the general favorites. As a rule they operate with an annoying jar and noise from the exhaust.

A complete exhibit of wood-working machinery is found in the same building. The logs are passed through the vertical saws of the ripper, cutting the whole, at the same time, into boards of any desired thickness. Then follows the various machinery for planing, trimming, turning and working.

In hydraulic machinery both France and Switzerland have extensive exhibits of horizontal and vertical turbines for low and high heads.

Darblay Père et Fils have a complete paper machine in active operation showing the whole process from the making of the wood or linen-pulp, its digestion, bleaching, dyeing and preparation for running, to its transit through the press from the agitators to the calenders. France has added a unique retrospective exhibition of the wonderful rise of the paper-making industry.

In printing machinery both France and Germany make a good showing. The superiority of American machinery is well illustrated by the press shown in the American Publishers' Building, where the Paris Exposition Edition of the "New York Times" is printed daily. Type-setting by machinery, matrix making and casting of a stereotype plate for a sixteen-page newspaper is in full view. The perfecting press of the Goss straightline type produces 50,000 eight-page papers per hour, printed, cut, pasted, folded and counted.

Fig. 4 shows French hydraulic machinery with belts of various materials in the balcony, that on the extreme right being a 2,000 H. P. belt made of strips of leather sewn together through the width of the belt.

Fig. 5 shows the Swiss hydraulic power and electrical machinery and a paper machine in the background.

Fig. 6 shows a portable traveling crane for unloading goods from cars at the Avenue Suffren entrance to the Electricity Building. Behind the crane is the base of the chimney of ornamental porcelain for the Avenue Suffren boiler house. The small building to the right is a post, telegraph and telephone station. A portion of the Great Wheel of Paris, 300 feet in diameter, carrying 1,600 people and modelled after the Ferris wheel exhibited at Chicago, is shown.

The Department of Finance exhibits a hand press for stamping medals and coins, of which there are a large variety on sale commemorating the Exposition. A constant crowd of spectators is gathered about the money press of The French Society of Mechanical Construction and that of L. Pinchart-Deny whenever in motion. The former, of the système Thounelier, turns out fifty medals per minute. The latter for stamping heavier medals claims an equal share of attention. An electric motor is geared directly to the horizontal shaft carrying the two vertical friction wheels on either side of the horizontal contact wheel and fixed to the vertical screw-pitched shaft carrying the die. By means of a hand lever, the polished surfaces of the friction wheels are thrown in contact with the leather bound rim of the die wheel, causing the die to descend with any desired speed. Automatic balances for separating the light, heavy and good coins are features of the mint exhibit.

* * *

One shop proprietor, who is using variable speed countershafts for his planers, states that as nearly as he can judge the final effect of the countershafts is to determine the highest speed at which the planer can be run. His mechanics adjust the speed of the countershaft to the highest practical point and then allow the planer to run at that speed, which is seldom varied. Even in the light of this experience he is still in favor of such countershafts. It is evident, also, that they are coming into more general use for planer driving, largely, probably, because they have been improved the past few years and now give less trouble than formerly. If any object to them as being not strictly in accord with the best ideas in mechanical construction, there is still open the plan of using stepped cones on the countershaft and the line shaft.

LARGE TRAVELING-HEAD SHAPER.

The shapers made by the Morton Manufacturing Co., Muskegon Heights, Mich., have the distinguishing characteristics that they operate on the pull or draw-cut principle, the cutting stroke being during what is ordinarily the return stroke in the common type of shaper. The effect of this construction is to draw together the different parts of which the shaper is composed—to close the joints, as it were—while the cut is in progress, and the harder the machine is worked, the closer the parts are drawn together and the more rigid the tool. An unusually long shaper ram can be used without vibration when operated on this principle.

For reasons that will be obvious, this construction is peculiarly adapted for large and heavy work, as, for example, castings that are so large that they cannot be conveniently placed on the planer, but which have short faces or bearings to be faced off. Some very heavy machines have been constructed by the Morton Manufacturing Co. for such work, some of which are of a portable type, to be set on any floor plate on which the work happens to be located, and others of which are attached to their own floor plate. One of the latter class is shown in the accompanying illustration.

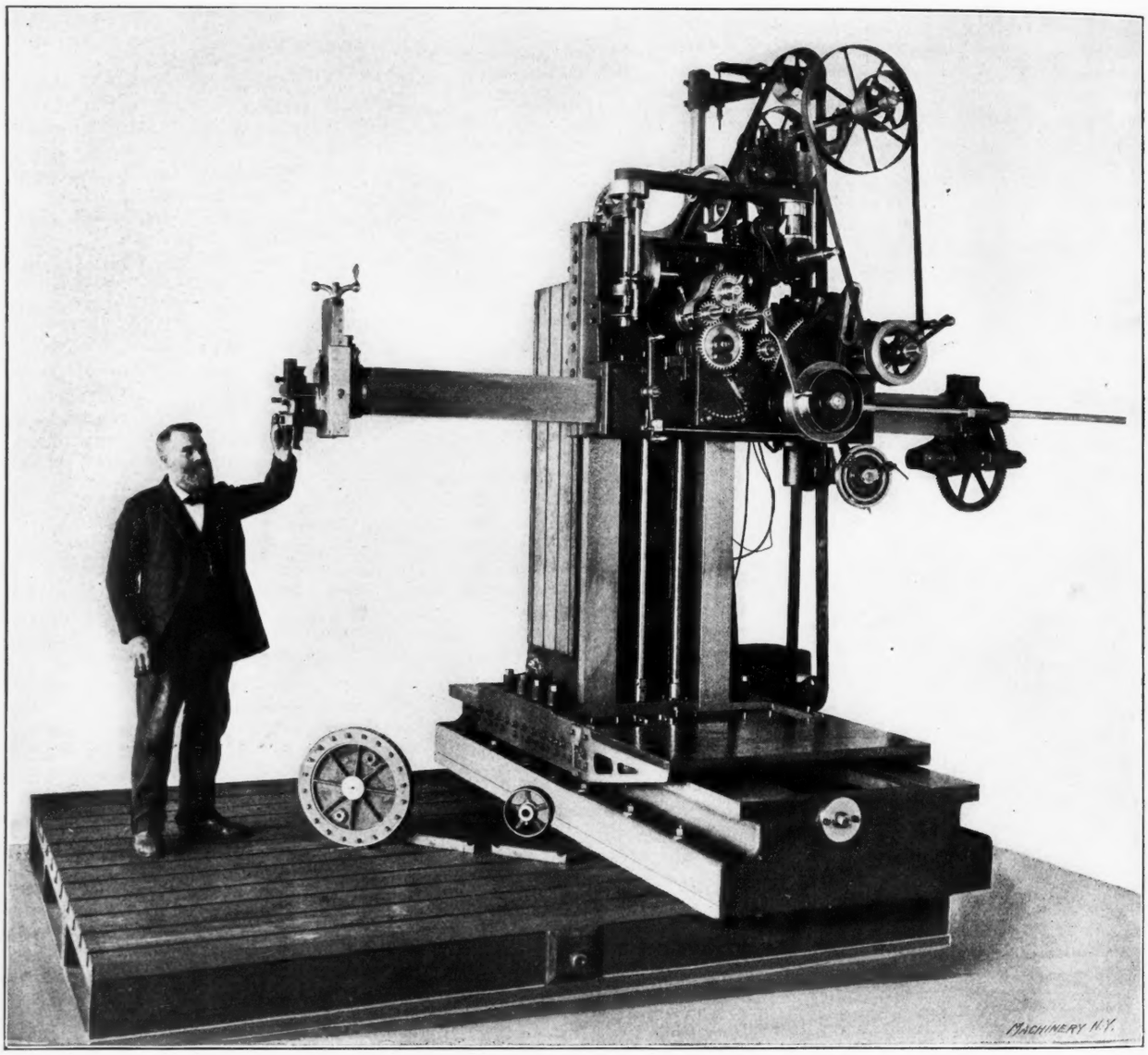

Fig. 1. Morton Traveling-head Draw-cut Shaper Weighing Sixteen Tons.

This machine has a floor plate 9′x10′ 6″, provided with T-slots, on which the work to be operated upon is placed. The bed is attached to the floor plate at right angles with the T-slots, and is heavily ribbed and cross-ribbed. A horizontally moving vertical column is gibbed and fitted to the bed, while the head carrying the shaper ram is capable of moving vertically upon the column.

This column is provided with square rail bearings, and upon it is located a vertically moving saddle or apron to which are attached the entire operating mechanisms of the shaper. The front side of the vertical column is also provided with a T-slotted plate. A brace can be placed between this plate and the work, thus holding the work rigidly when under heavy cuts. This column is also heavily ribbed and cross-ribbed, the metal being so distributed as to form the most substantial construction.

The vertical movement of the machine is 48 inches, logitudinal feed 78 inches, and it will admit of 6 feet between the ram and floor plate. Its total height is 13 feet and it weighs complete about 16 tons.

The ram is made of steel cast hollow, carefully fitted, and provided with wedge gibs for taking up wear. The machine obtains its reciprocatory motion through two friction clutches located on either side of the gearing and belted with an open and crossed belt from the countershaft, the ratio being such that the ram has a quick return of three to one. The friction clutches are positive in their movements and therefore the cutter will work close to a line and will carry a heavy cut. The shaper feed is operated by a self-driving friction. The feed screws are both stationary, the nuts revolving, they being fitted with ball-bearing thrust collars. It will be readily seen that by using the crank on the right-hand shaft, the apron of the shaper is made to raise and lower on the column, and by turning the left-hand squared shaft

the column is fed longitudinally on the bed. By this arrangement both feeds are entirely under control of the operator. The stroke is adjusted by means of tappets on a circular disk, and there is a lever conveniently placed for the operator, for reversing at any point of the stroke. The driving gearing is all cut from the solid, and is encased and runs in oil.

An interesting and unusual feature of this machine is a milling attachment that is designed for facing in a plane perpendicular to the line of direction of the ram. This attachment consists of a steel arbor passing through the ram, which has a train of gearing at the rear end and which can be easily removed by the operator when it is not desired to use it. The cutter head used on the milling attachment is seen lying on the floor plate of the machine.

Power for milling is supplied through a cone pulley and bevel gears to a splined shaft which engages the gearing at the rear end of ram. It is belted direct from the countershaft and has two changes of speed. The feed when used for milling is taken direct from the cone pulley by belting to the encased mitre gearing and through the cone pulleys to the friction disk and can be regulated by raising and lowering the friction wheel which engages the disk and can be reversed by moving to the opposite side. Connected with the shaft of this friction disk are a worm and gear by which power is applied directly to the feeding shafts. It will be readily

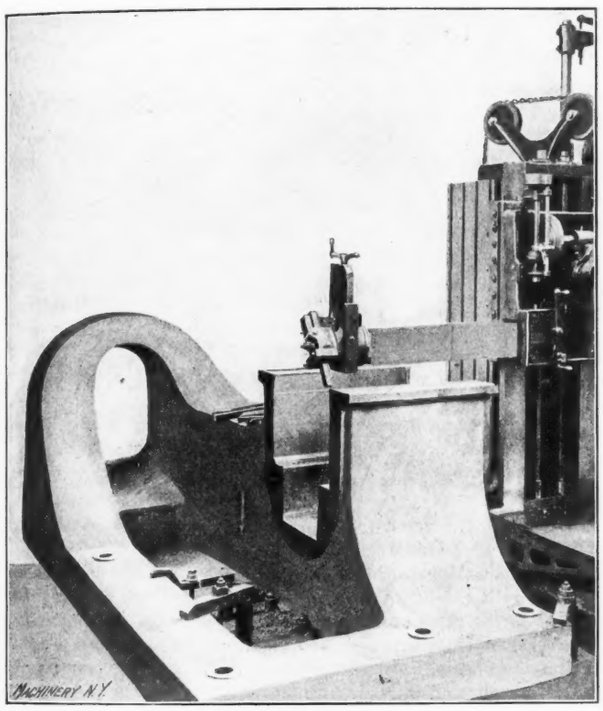

Fig. 2. Morton Shaper at work on a Bed Plate.

seen that this provides a continuous feed in either direction, enabling the use of a tool in the form of an ordinary milling head by which chipping strips and pieces can be faced from the sides of large castings. The machine is also provided with a friction clutch by which the countershaft can be stopped and started independently of the motor, and with this device, when moving the machine either vertically or horizontally by power, the machine itself remains idle. The vertical saddle is counter-balanced and power is applied through an endless belt, direct from the motor, which is so arranged that as the tool raises and lowers it does not affect the tension of the belts.

The machine is electrically driven, but can be furnished to be driven with a belt if so desired. It will be readily seen that the operator can adjust the stroke, control the feed, motor, and the entire machine from the platform made for this purpose.

As mentioned above, the machine is also constructed so that it can be easily detached from the bed, and can be used in connection with an ordinary floor-plate as a portable machine on heavy castings. It can also be provided with a small table of the ordinary box type, which can be bolted to the floor-plate and made of convenient height, upon which small work can be placed. In this way the machine will work successfully on small pieces as well as large. The floor-plate can also be constructed with a vertical floor-plate in connection with it, in a pit, so that by moving the machine to the front side of the floor-plate, heavy castings can be operated upon which could not otherwise be reached.

Cut 2 represents the shaper in the shops of the Hooven, Owens & Rentschler Co., at Hamilton, Ohio, at work on a large engine bed, planing out the pillow blocks. It will be readily seen that the pillow block may be fitted for the cap, and with the range of feeds, etc., the entire block may be machined with this tool. This illustrates only one of the many uses to which this machine can be placed.

* * *

An interesting feature of the present census compilation is the use of electric apparatus for tabulating the returns. From the schedules filled out by the enumerators, cards are punched on a hand machine to correspond with each person's age, color, employment, nationality, schooling, parents' nationality, etc., the location of the punched holes being determined by the conditions shown on the schedule. These cards are punched rapidly, the holes corresponding to the enumeration district being done automatically by gang punches. After these cards are punched (one being provided for each person), they are placed in the tabulating machine which automatically registers the cards on dials, each of which corresponds to some one condition, such as age, color, etc.

The manner in which this is operated is briefly described in principle. Imagine the cards laid out in a number of squares and each square corresponding to some condition which may be found by the enumerators and which is provided for by the questions asked. Corresponding to these squares is an equal number of plungers, having contact points at their lower ends. These plungers are held in a suitable frame which is depressed by a hand lever. When the card corresponding to any person's condition in life is placed in the machine and the plungers depressed, those corresponding to the openings punched out make electrical contact with a tiny cell of mercury beneath and thereby register on the dials for the contacts made. All the other plungers being prevented from making contacts, their dials make no record. In fact, if inconsistent holes are punched out by a careless operator, or if a card from a wrong district becomes mixed in with those for which the machine is set, the operator is at once given warning by automatic tell-tales. With one of these machines it is claimed that an expert operator can tabulate the returns for 50,000 persons per day.

* * *

KEYS AND SPLIT HUBS.

METHODS OF KEYING PULLEYS TO THEIR SHAFTS.

We have before called attention in these columns to methods of fastening pulleys, cranks, levers, etc., to their shafts, and have advocated the use of the split hub, clamped on the shaft by means of bolts in connection with a key. In view of two or three instances of this practice that have recently come to our attention, we will again refer to the matter, believing that whatever will help to abate the evil of keys, pulleys and cranks working loose is worthy of attention.

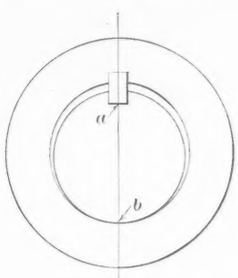

Fig. 1.

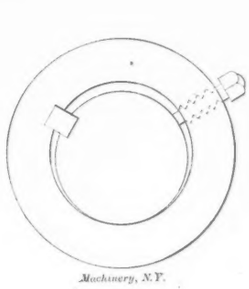

Fig. 2.

Very little fault can be found with a hub which is first forced onto the shaft and the key then carefully fitted so as to bear on the two sides of the keyway. Trouble begins when the shaft does not force into the hole and the tight fit is made by shaping the key so that it bears on the top and bottom, as shown in an exaggerated manner in Fig. 1. The shaft is then supported at

two diametrically opposite points, a and b, and the torsional strains will easily work the parts loose.

We frequently see both a set screw and a key employed in the same hub, the former serving in part to clamp the hub to the shaft and the latter to keep one from twisting upon the other. The usual position of the set screw is either opposite the key, at point b in Fig. 1, or else it bears directly on top of the set screw, producing the same effect as though the key bore on the top and bottom and no set screw were used. One way is equally as bad as the other, and there is nothing to prevent the hub working loose in a short time; when, of course, the set screw

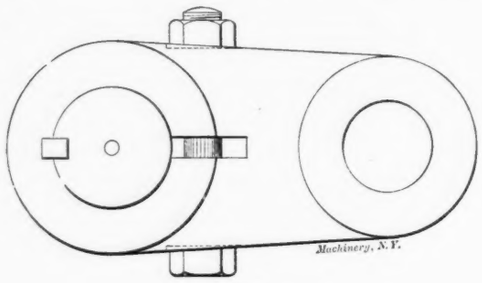

Fig. 3.

will be tightened by some one and the process repeated. If the set screw and key must be used together, let them be placed as in Fig. 3, where the bearing of the shaft in the hub comes at three equi-distant points, the best arrangement to give a firm bearing.

Any makeshift, however, for a solid, force-fit bearing of the shaft in its hub is not strictly what may be called good practice. The best fit is obtained when the shaft is turned large and either forced in the hub or the hub shrunk on the shaft. On the other hand, the work is often of such a character that neither of these methods is either satisfactory or desirable. Take the valve stems of Corliss engines, for example. These must sustain considerable torsional stress and their movement is intermittent, tending to work the valve levers loose on their stems. If the levers do not fit well enough to drive on to the stems with a sledge, it is quite certain that they will cause the engineer annoyance; and if, as is too often the case, these stems are finished by filing in the lathe, their surfaces will be so uneven that after driving the levers on and off a few times, they will be a free running fit on the valve stems. On the other hand, if the holes in the levers are reamed and the stems ground, the surfaces will be so perfect that they will wear indefinitely, but they will also be so unyielding that

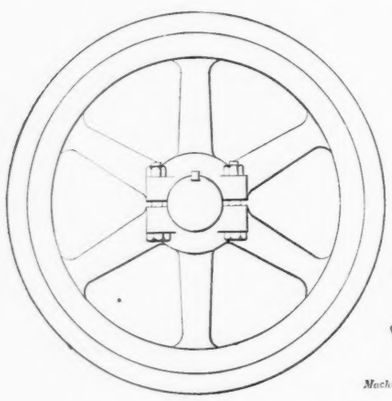

Fig. 4.

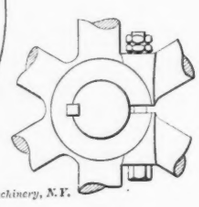

Fig. 5.

it is not commercially practicable to do the accurate work needed to make the fits as they should be. The Rice and Sargent Engine Co., Providence, R. I., at one time were fitting a number of 3-inch valve stems to cast-iron levers in which standard holes were reamed, and it was found that if the stems were ground ¼ of a thousandth, in excess of the diameter of the hole, this was all that could be allowed to enable one to drive on the levers with a sledge, to say nothing of being able to get them off again. No one, however, would pretend that quarter-thousandths of an inch are a success in commercial engine works.

Such considerations as the above, coupled with the difficulty of forcing hubs, etc., on or off, has led a number of engine builders to clamp the hub to the shaft with bolts and then depend on the keys simply to prevent twisting, as suggested at the beginning. While such a method is a compromise, it is not a makeshift, and one's common sense will dictate where such construction is advisable. In Fig. 3 is a small crank or lever, which we have shown in a previous number. This is used by the C. W. Hunt Co., New York, and has also been adopted by the Lane & Bodley Co., Cincinnati, on their latest type valve gear, and by the Westinghouse Machine Co., Pittsburg, Pa., for the valve stem levers of the mammoth Corliss engines now in progress of construction for the Third avenue road of New York.

In flywheel work the Westinghouse Machine Co. adopt substantially the same system. One of their wheels is sketched roughly in Fig. 4, and will be seen to consist of a solid rim, with the hub split on two sides. This relieves the strains in the arms when the casting is cooling, enables the wheel to be easily put on or taken from the shaft at any time, and the bolts will clamp the hub so tightly that if the key is properly fitted there is no possibility of the wheel working loose. If any doubt the efficacy of the bolts in such a position, they simply need to recall that split flywheels of all sizes have always been used with success, and it is not a difficult matter to design the hubs of such wheels to have nearly as great strength through the hub joints as through any other part of the hub. In Fig. 5 is another form

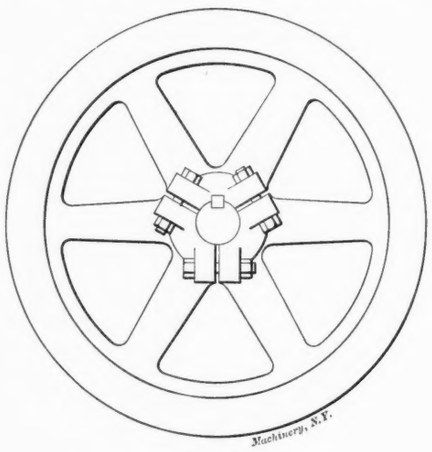

Fig. 6.

of flywheel hub upon the same principle, as made by the Ball Engine Co., Erie, Pa.

William Sellers & Co., Philadelphia, Pa., use the construction shown in Fig. 6 for the flywheels of their punching and shearing machinery. The hub is split into three sections and is clamped by three bolts on each side of the wheel. While this is a somewhat complicated construction, it has the merit of clamping the shaft evenly and of giving almost perfect relief to the internal strains in the arms of a solid wheel when cooling in the mold. A flywheel could scarcely have more severe work to do than one attached to machinery of this character and there is scarcely a place where a wheel would be more likely to work loose. If the split hub and key work well here, as we presume they do, there need be no hesitancy in applying the same or similar construction in almost any place where it is found convenient to do so.

* * *

There seems to be an effort on the part of many of the manufacturers in the cities of the soft coal districts to ameliorate the effects of the smoke nuisance to some extent. Prof. Benjamin, of the Case School of Applied Science, at Cleveland, has some chimney photographs entitled "To smoke or not to smoke," which show the results obtained with properly installed mechanical stokers and without any such appliance. Many firms are now introducing stokers, down-draft furnaces, etc., for the express purpose of reducing the smoke and with good success. It is proven beyond question that the better grades of soft coal can be burned in factory boilers without black smoke, except when cleaning fires. What is needed is regular firing and suitable means for bringing the gases and carbon passing off from the fresh coal intimately in contact with sufficient heated air to insure combustion.

GAS ENGINE DESIGN.—8.

IGNITERS, THEIR CLASSIFICATION AND DESIGN.

E. W. ROBERTS.

There is probably no subject in gas engine design that has produced more trouble or annoyance to the builder, as well as to the user, of the engine than that of ignition. The writer believes that as many engines have been unsuccessful because of a faulty ignition device as from all other causes combined. The reason is that too early or too late ignition—either one—will cause a falling off in power and if ignition is interfered with from any cause, and for any length of time, the engine will stop altogether. Again, the economy of fuel consumption depends, in a great measure, upon the proper timing of the ignition.

In order that the reader may thoroughly understand the discussion of the subject that is to follow, it will be necessary to briefly outline the various methods that have been in use and are now employed, and to point out the inherent faults of each method. Electric ignition, which is now becoming such a general favorite among the majority of gas engine builders, was the first to be employed upon a commercial engine. Because of a poor understanding of the principles involved, it was abandoned for ignition by means of a flame such as is familiar to those who know the old slide-valve Otto engine. Later, ignition by means of a hot tube was introduced, while in the interim many experiments were made with other methods. These methods were briefly as follows: In an engine experimented with by Mr. Dugald Clerk, the writer of the well-known book on gas engines, he used a slide containing a grate made of thin strips of platinum which were kept at a high temperature by the combustion of the gases in the cylinder and retained sufficient heat from one charge to ignite that which followed. This device was successful with engines in which no explosions were omitted, but in a hit-and-miss method of governing, the grate would cool down during the idle strokes until its temperature was insufficient for ignition of a succeeding charge. Another method in which the operation and the difficulties encountered were precisely similar to the above, was the use of a long bolt screwed into the piston. The bolt was necessarily a slender one in order that it might reach incandescence readily. A similar device employed was a bolt or pin projecting from the cylinder head into the compression space.

A suggestion which was made, but which the writer does not believe has ever been carried out, was to use a small quantity of gas such as phosphuretted hydrogen and to inject this into the compression space at the proper time for ignition, the injected gas having the property of taking fire immediately upon coming in contact with the air in the charge. A method which is in use upon several engines employing kerosene as a fuel, is to divide the compression space and keep a portion of it unjacketed so that it will remain at a comparatively high temperature and act much in the same manner as the familiar ignition tube. The ignition tube itself is nothing more nor less than a small cylindrical chamber which is kept at a red heat by means of a flame on the outside of the tube and which ignites the charge when a portion of it is driven into the tube and comes in contact with the heated point on the inner surface. The very latest method of ignition is one in which the fuel is not allowed to come in contact with the air until at the end of the compression stroke. By compressing the air to a high pressure, it is raised in temperature until it is heated to a degree equal to the combustion temperature of the fuel and the fuel, being admitted at the termination of the compression stroke, burns as it enters. The method of ignition just described is that employed by the now well known Deisel motor.

At the risk of controverting the statements of quite a number of gas engine builders, the writer would say that he believes that hot tube ignition will, in time, be entirely superseded by electrical methods. With the exception of the material of which the tube is composed, the tube igniter has practically reached a standard form, and as such it is used by the majority of those gas engine builders who still employ this method of ignition. It consists of a tube having an inside diameter of from ¼ inch to ⅜ inch and which is from 4 to 8 inches long. This tube is usually surrounded with an outer cylinder or chimney nearly always lined with an innner tube of asbestos. The tube is heated by a Bunsen burner giving a flame of sufficient size to bring it to a cherry red heat. These tubes are variously made of wrought iron, of platinum, of porcelain or of a nickel-steel alloy. Wrought iron is the cheapest material when the cost of a single tube is considered, but, as they rarely stand more than two or three days of continuous use, they are very expensive in the end. Platinum tubes have a longer life than wrought iron, but are very expensive at the start, and, as compared with nickel-alloy or porcelain, they are comparatively short lived. The great difficulty with porcelain is its liability to crack when exposed to a sudden draft during the time it is at its high temperature. Nickel-alloy will last much longer than any other metal and has none of the objections credited to porcelain.

At the present time ignition tubes are very seldom made with a valve for regulating the exact time at which ignition shall take place. The timing of the ignition is regulated entirely by the amount to which the mixture must be compressed before the fresh charge can drive the products of combustion remaining from the previous charge far enough back in the tube to permit the fresh mixture to reach the red hot portion. The great objection to this method is that the timing of the ignition is very imperfect and is scarcely ever exactly twice alike. There are too many factors which will interfere with the proper timing. For instance, a leaky piston or valve, a change in the proportions of gas and air, or a slight alteration in the location of the "hot spot" on the tube, besides quite a number of other apparently insignificant factors will interfere with the action of the igniting device and alter the lead of the ignition.

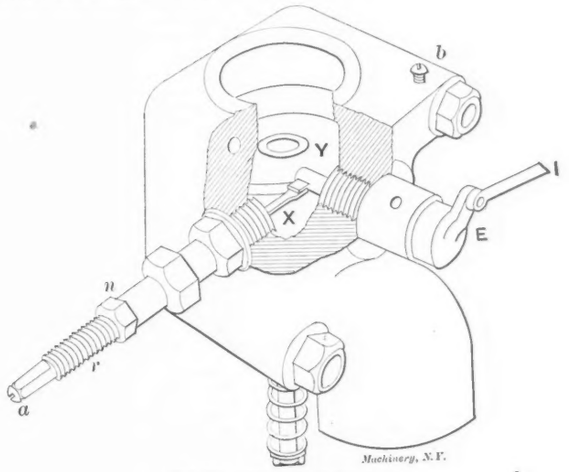

Fig. 35. Wipe-break Igniter.

Flame ignition will, in all probability, never be used again on a gas engine, for the simple reason that it is troublesome to manage on an engine having high compression, and, in a small engine, the percentage of gas used by the ignition device makes up a considerable per cent. of the total amount used for the engine. It is also quite likely to be blown out by any unlooked-for current of air or by any leak in the valve controlling the ignition. It has been practically abandoned for tube or electric ignition by all prominent gas engine builders. Electric ignition, which is the method now in most general use and which will probably supersede every other, with exception of the method employed in the Deisel motor, is the only one which the writer believes it is necessary to consider in this article. Electric ignition may be divided into two separate classes: the one in which the ignition is produced by interrupting a primary circuit flowing through a coil having a great deal of self induction, and the other by interrupting a primary circuit and employing this interruption to induce a current of high tension in a secondary circuit, producing a spark which will jump across an air space. The first method is that which is known as the make-and-break; the other is called the jump-spark method of ignition. The make-and-break method may be further divided into two classes: the one which is called wipe-break for the reason that one terminal is caused to rub upon the other and to suddenly let it go, the circuit being closed during the rubbing and a spark emitted just as the electrodes separate. The other has been called by several names, but the name which the writer thinks fits the case the best is the term "hammer-break." In this method, one electrode is forced hard against the other, closing the circuit, and then is suddenly with-

drawn by means of a spring. Of the two, the wipe-break will give a more powerful spark upon an equal amount of battery power than will the hammer-break. The objection to the wipe break is, however, that the constant rubbing causes a great deal of wear and the electrodes need frequent adjustment while it usually necessitates a spring within the compression space and exposed to the heating effect of the combustion. This objection of having the spring within the combustion space has been overcome in some designs, but as a general rule the above statements fit the designs that are already upon the market. The hammer-break, however, does away with this objection, as there is no rubbing and the touch may be sufficiently light to avoid undue wear of the parts, so that adjustment need not be made except at long intervals. While it has been claimed for the wipe-break that it automatically cleans itself of any collection of soot or oxide due to corrosion, the hammer-break may be so designed that it may be cleaned from the outside without removing the mechanism from the cylinder.

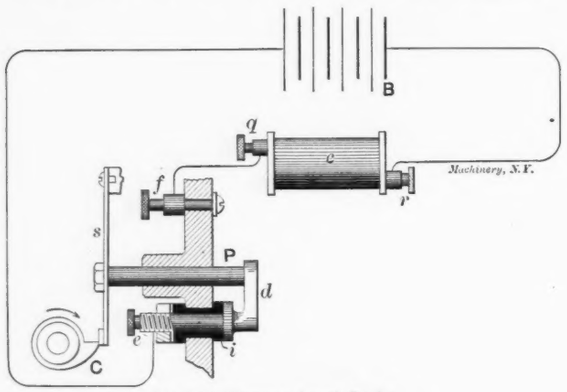

Fig. 36. Hammer-break Igniter.

An example of a wipe-break which is in use on a very successful gas engine is shown in Fig. 35. The two electrodes are shown at X and Y, X being the stationary electrode, while Y is rotated by the crank E. The electrode X is a flat spring which is deflected by the projection on Y at each rotation of the crank, a spark being emitted as the point of Y slips off of X. The electrode X is insulated from the frame of the engine and one of the wires is attached to it at A. The other wire is attached to b or to any other convenient point upon the body of the engine. Attaching one wire to the frame of the engine is usually termed "grounding" one side of the circuit on the engine. The adjustment of the electrode X is made by loosening the nut n and screwing up the threaded rod r to which the electrode X is attached. A good feature of this design is that the electrodes are placed in the inlet valve box where they are subject to the cooling effect of the entering charge. Much of the trouble usually caused by the spring X being within the combustion space has been overcome by this arrangement.

The principle of operation of the hammer-break is shown in the diagram Fig. 36. In the figure, B represents the battery or other source of electrical energy as, for instance, a dynamo. The spark coil is shown at c and consists of a core of small iron wire about which is wound a coil of insulated copper wire of considerable current-carrying capacity, No. 14 or No. 16 B. & S. G. being the sizes usually employed. The movable electrode is shown at P and the stationary electrode at d. The electrode P is illustrated as being attached to a flat spring s which is depressed by the cam C carrying with it the electrode P and pressing it against d. After P has come in contact with d and is prevented from moving further, the portion of the spring which is nearest the cam is deflected, causing a pressure between P and d and effectually closing the circuit through the battery, the coil and the two electrodes. As the projection of the cam passes the end of the spring, the latter slips off, and electrode P is drawn quickly from contact with d, forming a rapid break and producing a spark between the electrodes on account of the breaking of the circuit. The circuit shown may be easily traced; one wire from the battery passing to the binding post on the end of d and the other to the binding post r on the coil, from the coil the circuit continues from the binding post q to the binding post f which is grounded upon the engine. The stationary electrode is insulated from the engine frame by mica or similar material as indicated by the full color at i.

The reader should note that the diagram in Fig. 36 is not intended to represent an actual device which is in use upon any engine. In fact, the writer does not advise the use of a flat spring at any point about a gas engine for the reason that, unless it is tempered with exceedingly great care and skill, it is apt to break without warning. The cleaning already spoken of may be effected from the outside of the engine by rotating the electrode P and at the same time pressing it against the stationary electrode d, it being, of course, necessary so to design the mechanism that this may be done.

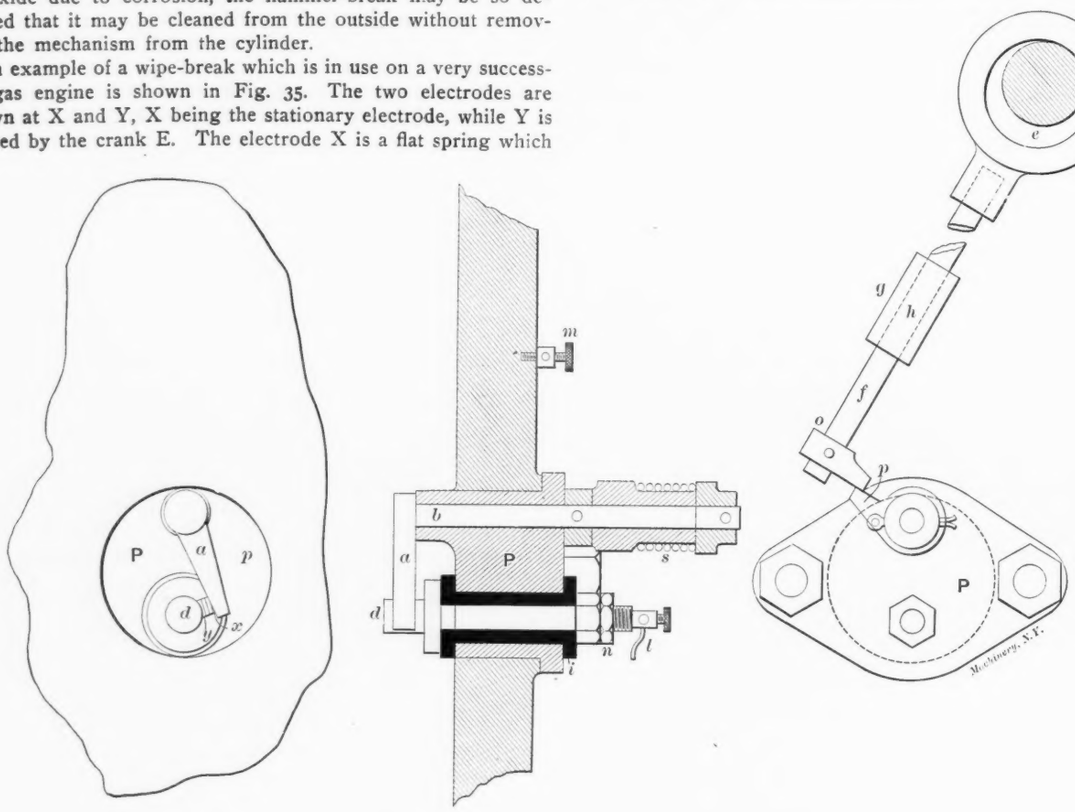

Fig. 37. A Common Form of Hammer-break Igniter.

A form of hammer-break which is used by a great many gas engine builders is illustrated in Fig. 37, the stationary electrode being shown at d, and being insulated in the usual manner from the engine by means of the insulation i which is fastened into the plug P by the nuts n and the plug is then bolted to the cylinder head or some other convenient portion of the engine so that the point d projects into the compression space. The movable igniter is shown in the several views at p and consists of a rod with an arm a. Two small rivets of platinum are inserted into each of the electrodes as shown at x and y. These points

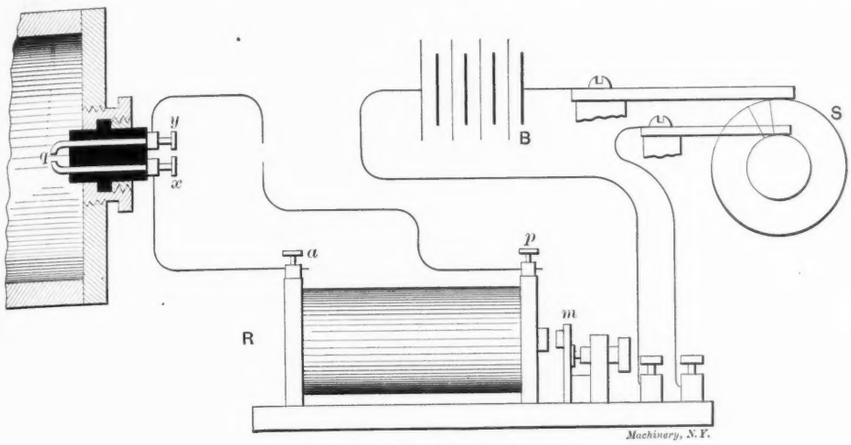

Fig. 38. Jump-spark Method of Ignition.

are employed in order to avoid the rapid destruction which would otherwise occur if they were not present and if contact were made between the wrought-iron surfaces of the electrodes. The arm a is attached to a shaft b which passes through a bushing to the outside of the engine and has upon its other end a hardened steel projection z. About that end of this shaft which projects from the outside of the engine, is a helical spring s, one end of which is fastened to z and the other to the rod. Upon some convenient portion of the camshaft is an eccentric e carrying a rod f which passes through a guide g, g being allowed to turn about a pin located at the point h. On the end of f is a hardened steel projection o. As the cam rotates, the rod f is thrust in the direction indicated by the arrow, the projection o coming in contact with z, rotating it and carrying with it the rod b until the electrodes are in contact, after which further rotation of z winds the spring s increasing the pressure between the points x and y. Further motion of the rod f allows o to slip off of z and z flies back owing to the tension of the spring and carries with it the rod b and the arm a, breaking the circuit with a rapid motion and producing a spark between x and y. The wires from the battery and the spark coil are attached at l and m, m being grounded at some convenient point upon the frame.

In the design of a device of this kind the following precautions should be observed: Make the projection d and the arm a so that they have considerable body, in order that they may not become overheated by exposure to the charge when it is being burned. For the same reason the platinum points x and y are preferably made of large diameter and quite short, say at least 3-16 of an inch in diameter and not over 3-32 to an ⅛ of an inch in length. Wherever possible, the igniter points should be placed in the path of the incoming air in order to avoid overheating, as it will be found a rather difficult matter to keep them cool by means of the water-jacket. Under no circumstances should they be so placed that they are subject to the entire heating effect of the exhaust as it passes from the cylinder, without provision being made for keeping them cool.

The jump-spark method of ignition is illustrated in Fig. 38, and is as follows: Current passes from the source of energy B through a switch S which is placed at any convenient point upon the cam shaft. From the battery and the switch, current passes through the primary circuit of the induction coil R. At a and p are shown the terminals of the secondary circuit of the induction coil from which wires are led to the binding posts x and y of the ignition plug. In the figure is shown a magnetic circuit breaker at m, the operation of which is too well understood to need description in this article. This circuit breaker is not always used, for, in many cases, the designer depends on the induction of a single break in the primary circuit. The operation of the device is as follows: The primary circuit is closed at the proper time by the switch S and, in case the circuit breaker m is employed, the circuit is rapidly opened and closed producing a series of sparks between the points of the ignition plug at q. When no circuit breaker is employed, two sparks are formed, one when the primary circuit is closed by the switch and another when the circuit is broken. Of the two, the spark made when the primary circuit is broken is the more powerful and is that generally depended upon for igniting the charge. In some designs, but one of the terminals x y is insulated, the other side of the secondary circuit being connected through the frame, and the igniter point corresponding to that side is fastened to the igniter bushing. In case this method is used, it is customary to complete the primary circuit by means of wires and not to ground it, as it is claimed that if both circuits be grounded on the engine, perforation of the insulation in the coil is quite likely to result.

The great trouble with the jump-spark method of ignition is from two causes: one, the bridging of the gap at q by a deposit of carbon or other foreign matter allowing the secondary current to pass without sparking; and the other is the breaking down of the insulation due to the high tension of the secondary current.

The most practical method of avoiding the first of these troubles is to use only the requisite amount of lubricating oil for the cylinder and to use a quality of cylinder lubricant which will give the least deposit of carbon. The trouble from breaking down the insulation may be avoided to a considerable degree by the use of a comparatively low tension in the secondary circuit. It is not necessary to use a pressure in the secondary circuit which will jump across a long gap. The best results, in the opinion of many experimenters, may be obtained from a fat spark which will jump across a maximum gap of ⅜ to ½ inch and to so place the igniter points that they are about 3-32 to ⅛ of an inch apart. For insulation, both lava and porcelain have been used. In either case, a good grade of material should be employed and the insulation should be thick enough to avoid breaking from shock, or piercing by means of the secondary current.

* * *

SHOP TERMS ILLUSTRATED.

WATER FINISH.

BALL BEARINGS

NOTES ON THE NUMBER AND SIZE OF BALLS TO BE USED IN BALL BEARINGS.

D. T. RANDALL.

Recently the writer had occasion to look into the subject of ball bearings, particularly in regard to the relation between the size and number of balls used and the pressure or load to which the bearings may be subjected. A search through available engineering literature for some recognized standards of practice and for results of experiments on ball bearings under various conditions, resulted in finding comparatively few articles on the subject, except such as relate to the design of bearings, under light loads, to prevent friction from the twisting or spinning motion of the balls. Of these there are many, and the theories are almost as numerous as the writers. However, a number of important facts and principles were collected from the few articles found on the subject under consideration, and, believing that such a collection cannot but be of value to those who may as yet have had little experience in the design of ball bearings, the writer submits the following notes, with no claim to originality unless it be in the matter of selection and arrangement.

The chief advantage to be gained by the use of the ball bearings are less frictional resistance, and very high allowable speeds. These facts are so familiar and have been so often demonstrated by experiments as to need no further remarks.

In designing a ball bearing one knows, or should know, the greatest pressure to which it will be subjected and also whether the diameter of the ball races will be limited by other parts of the design. Having this data, there remains to be determined the size and number of balls and the best form of bearing surfaces for the given conditions. In general we know that large balls are most efficient, but extreme cases of loading or other conditions may make it desirable to know the smallest size and number of balls that may be used and yet have the bearing reasonably efficient and durable. In Kent's Mechanical Engineer's Pocket-Book may be found the following statements: "Balls should be of the largest possible diameter which the space at disposal will admit of; any one ball should be capable of carrying the total load upon the bearing; the frictional resistance is proportional to the load; friction is inversely as the diameter of the balls, probably as the square of the diameter; friction is independent of the number of balls and of the speed." The importance of ball bearings is gaining recognition, and recently experiments have been carried on to determine the relation between the pressure on the bearing, the number and size of balls and the form of the ball races to secure an efficient bearing; also on the strength of the individual balls to resist crushing.

Mr. J. F. W. Harris, in Transactions of American Society Mechanical Engineers, 1899, gives results of tests on steel balls of several makes, which show that we may expect a one-fourth inch ball to break under a load varying from 5,500 pounds to 8,600 pounds, according to the make of the balls; a three-eighths inch ball to break under loads from 10,500 pounds to 14,900 pounds, and a half inch ball, under loads from 13,000 pounds to 40,000 pounds (range of values for four makes). In this connection the author makes an interesting statement to the effect that few of the common tool steels can be hardened sufficiently to resist indentation when pressed upon the balls.

Owing to the wide range of values obtained it is difficult to fix a value for the various sizes. For the purpose of the designer, the strength of balls of the same make may be taken as directly proportional to the square of the diameters of the balls. The most complete article on ball bearings that has come to the notice of the writer is in Die Maschinen Elemente, by C. Bach, who is recognized as the best German authority on machine design. As an introductory remark the author says that it is difficult to secure an even distribution of pressures on the balls and that this fact must be taken into account when designing ball bearings. The following general formula is given: $P = KId^2$.

In which P = pressure on the bearing,
I = the number of balls under pressure,
d = the diameter of the balls,
K = a variable coefficient.

As shown by the formula, if the same size of balls be used, the allowable pressure depends directly on the number of balls. The pressure that may be sustained by one ball under good conditions is directly as the square of the diameter; that is, one ball one-inch in diameter is equivalent to four balls one-half inch in diameter. This fact may be explained as follows: All materials are more or less elastic; a large ball will be depressed less deeply into its track before securing a sufficient bearing surface than a small one. It is to lessen this action between balls and their bearing surfaces, as well as to overcome the inaccuracies of these parts, that large balls are recommended.

The author gives the following values for K: (a) for hardened steel balls in hardened steel grooves of the shape of an arc, with a radius equal to 9/16 of the diameter of the ball; K may be taken as high as 4,500, when all the conditions may be perfect; (b) for hardened steel balls between flat hardened steel plates; K may be taken equal to 90. Owing to the small contact between the ball and the flat plate, K is of necessity small. The fact that the groove of a small radius will permit so great an increase of load may be explained as above for large balls. Evidently a groove of the same radius as the ball will endure a very heavy pressure, but, as has been shown by experiment, it will develop excessive friction, due to its unavoidable twisting in its motion about the ball circle: (c) for cast iron balls between flat plates; K may be taken between 30 and 50; (d) for cast iron balls in cast iron grooves in form of a circular arc having a radius of 9/16 d; K may be taken as high as 1,800 under good conditions. The author also treats of the proper forms of ball races to lessen friction. As the contact is lessened, K must be correspondingly lessened. The above formula enables one to determine the smallest size of balls to be used in order to secure an easy running bearing in which the wear on the balls and grooves will be small. In all cases where circumstances will permit, balls of larger diameter may be used to lessen the frictional resistance. In many lightly loaded and high speed bearings, balls of such a size and number are so used as to reduce the load on each ball to a mere fraction of that which might safely be carried.

In a series of tests on the friction of end-thrust ball bearings, published in "The American Machinist" January 5, 1899, Mr. Thomas Hill shows results in favor of flat plates for bearing surfaces. The V-grooves or four-point bearings gave about 11 per cent. higher frictional resistances. Circular grooves, with a radius equal to that of the balls, gave high resistances on light loads when compared with those of flat plates, but under heavy loads there was not so wide a difference. In the same periodical Mr. Reynold Janney gives results of experiments to determine the necessary angle between two surfaces which are in contact with the ball, in order that the ball may be crowded back to its proper path, against its own weight, in case it should

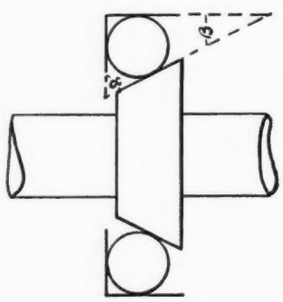

Fig. 1.

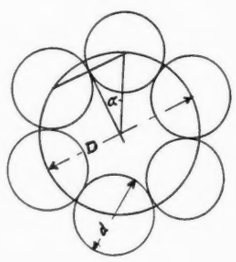

Fig. 2.

leave that path by reason of looseness of the bearings. The conclusion arrived at is that the angle should never be less than 25 degrees. This conclusion is of such importance that it must not be disregarded in the design of ball bearings. Fig. 1 illustrates the requirements for a three-point bearing, each of the angles alpha and beta being equal to or greater than 24°. After deciding upon the number and size of balls to be used, the diameter of the circle passing through the centers of the balls should be found. Or if the diameter of this circle be limited between certain sizes, then the proper number and size of balls must be found to correspond. The relation between the ball circle and the number of balls of a given size may be found graphically by a few trials on the drafting board, but may be obtained more accurately by mathematical solution from the

fact that the radius of the ball equals the radius of the ball circle multiplied by the sine, of 180 degrees, divided by the number of balls. This may be seen by reference to Fig. 2. Let n = number of balls. R = radius of the ball circle, r = radius of the ball. Then $r = R \sin a$ or $R = \sin \frac{r}{\frac{180}{n}}$ the angle a being equal to $\frac{360°}{2n}$. D = 2R. This result is the exact radius of the circle on which the centers of the balls will lie when their surfaces are in contact. It is desirable to allow some space between the balls, say .005 of an inch between each two balls. In general the total space allowed should not exceed one-fourth the diameter of one of the balls. If the total clearance be decided upon, it can be approximately allowed for in the radius of the ball circle by adding to the exact radius one-sixth (1/6) of the clearance desired. Below is a table giving diameters of ball circles for one-inch balls. Diameters for other sizes of balls may be obtained by multiplying the results in the table by the diameter of the balls to be used. Thus, if one-half inch balls are to be used, take one-half the diameter of the ball circle found in the table for the given number of balls.

Exact Diameters of Circles passing through the Centers of 1-inch Balls.

No of Balls.	Diam. of Ball Circle.	No. of Balls.	Diam. of Ball Circle.	No. of Balls.	Diam. of Ball Circle.
6	2,000	15	4,810	23	7,345
7	2,310	16	5,125	24	7,662
8	2,612	17	5.440	25	7.978
9	2,923	18	5,758	26	8.296
10	3,236	19	6,075	27	8,615
11	3,548	20	6,394	28	8,934
12	3,864	21	6.710	29	9,249
13	4,179	22	7,027	30	9,566
14	4,494				

To design the bearing after having found the above relations, it is first necessary to locate the centers of the balls on the drafting board at the distance from the axis of the bearing equal to the radius of the ball circle, as found by the table or graphically, and then design the bearing parts about the balls as in Fig. 3. The design of the bearing parts, to prevent friction and the consequent wear due to the twisting and spinning of the balls, is accomplished by making the parts of such shape that each ball will take up a constant individual axis about which all points in its surface tend to rotate, this axis being in motion, one end always pointing to a fixed point in the center of the shaft or axle of the bearing. The various methods of obtaining these results are not within the scope of this paper, and the reader is referred to the many articles which have appeared in recent technical literature.

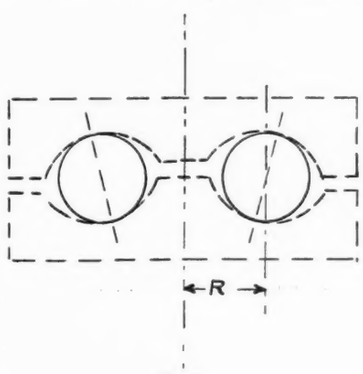

Fig. 3.

* * *

BOATING ON THE OHIO.

To an eastern mechanic there is no more interesting feature in the Central West than the light draft river boats. Those who attended the Cincinnati meetings of the A. S. M. E. and went on the excursion down the Ohio River had a good opportunity to study the marine architecture of that section, and many commented on the apparent discrepancy between the shallow draft and the spacious cabin and deck room of some of the boats.

These vessels draw from one to two feet of water only, and, of course, all freight must be carried above deck. The actual tonnages, therefore, are not as great as the imposing appearance of the craft would indicate, because the deep-draft vessels with which we contrast them carry immense cargoes below the water line, besides the freight, live and otherwise, on the decks.

The chief aim of the builder appears to be to make a boat as flexible as possible—something that will squirm over obstructions about as a snake overcomes obstacles in his path. According to all accounts it is entirely possible for a boat to navigate a considerably less depth of water than its own draft; in fact, it is said they will navigate a heavy dew. While we have not seen it done, it is asserted that to float over any ordinary obstacle the bow is lifted as high as possible by tackle attached to heavy poles driven alongside into the river bottom. The engines are then reversed full speed, which rushes the water ahead, upstream; and when the wave returns the engines are driven ahead and the boat thus rides the wave and mounts the obstacle. The machinery is peculiar to itself and has been developed by years of experience with the trying conditions of river navigation. It is hard to make an eastern man believe that the valve gear and other details could not be advantageously modified, but western men refuse to admit that any other type would do the work at all and we presume that if shallow rivers exist in Jupiter or Mars, they would expect to find that substantially the same class of machinery had been developed for the boats there as here, so perfectly does it fulfil the conditions.

Both stern and side-wheelers have horizontal engines with very long stroke, which are capable of running cool however much their flexible foundations may twist or deflect. Cams are employed instead of eccentrics, which give an intermittent motion and fixed cut-off to the gear. Poppet valves are used and they are operated by a tappet motion and reversing gear, similar to one of the earliest locomotive reversing gears. There are two engines on each boat which are independent except for connections calculated to keep the two valve gears in unison. On some of the engines the gear is simple and on others very complicated. On all of them it is noisy.

The stern wheelers have hexagon wheel shafts of wrought iron. The arms to which the paddles are attached are bolted to cast-iron spiders or hubs, with rough hexagon holes to fit the shafts, and they are attached to the shafts by wedging in place. The connecting rods are as likely of wood as of iron and in any case are so long that they must be trussed to prevent deflection and vibration.

The boilers as well as the engines have characteristics of their own and are a modified form of the ordinary horizontal boiler, but without the brick setting. The newer boilers generally have two or more flues. The shells have a sheet metal covering, lined with fire brick, and the covering is far enough from the boiler to leave a passage through which the gases from the fire box can pass around the outside of the shell, before returning to the uptake, through the flues. About 125 pounds pressure are carried and it is usual to have a float water-level indicator in place of a water glass.

The waters of the Ohio rise and fall to such an extent that none but floating wharves are possible and ordinarily no wharf is needed at all. The boat runs close in shore, and the gang plank, which is ever ready, suspended from a derrick on the forward deck, is swung out far enough to rest on the dry land, while the hawser is made fast to any convenient tree, or perhaps not made fast at all.

* * *

Two or three times we have called attention to the practice of cutting spiral oil grooves in the shafts and journals of a machine instead of in the bearings in which the shafts run. Two months ago we reported that this practice was followed by the Bullard Machine Tool Co., Bridgeport, Conn., and we have also observed that it is practiced by a number of other builders. While we believe this is the most satisfactory plan for oil grooves, for many classes of work, its greatest advantage is realized in extremely heavy machinery. Oil grooves will fill up and in heavy machinery they will not only fill up with dirt, but with particles of the soft metal of which the boxes are generally made. This is particularly the case when the bearings are new and the shafts are seating themselves. At that time the most oil is needed and it is the most difficult to get oil to the bearings because the grooves are filled up during the first few day's run. The writer noted recently a rolling mill engine of several thousand horsepower that was being built by Mackintosh, Hemphill & Co., Pittsburg, Pa., in which grooves in the shaft were specified by the engineer contracting for the engines. In work of this class it is almost impossible to lift the shaft in order to remove the shells for cleaning, but where the grooves are in the shaft they can not only be cleaned easily, but they distribute the oil more thoroughly.

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Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

A practical journal for Machinists and Engineers, and for all who are interested in Machinery,

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

ONE DOLLAR A YEAR, POSTAGE PREPAID, TEN CENTS A COPY.

FOREIGN SUBSCRIPTIONS ONE DOLLAR AND FIFTY CENTS A YEAR.

Lester G. French, Editor.
Fred E. Rogers, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

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UNITED KINGDOM.—Sampson Low, Marston & Co., St. Dunstan's House, Fleet Street, London, E.C.

JULY, 1900.

CIRCULATION STATEMENT.

The regular edition of MACHINERY for July is 22,000 copies.

MACHINERY has the largest paid-in-advance circulation of any mechanical paper in the world. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. Except on special quarterly numbers, no papers are sent free other than to advertisers, exchanges and circulation agents. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. The regular editions of MACHINERY for the last twelve months are given below:

1899.		1900.		1900.	
August	17,150	January	20,000	June	27,500
September ..	18,000	February ...	20,500	July	22,000
October	17,500	March	25,000		
November ..	17,750	April	21,500		
December ...	18,500	May	21,500		

A NEEDED SHIPPING LAW.

The general public is probably not aware of the enormous annual loss of lives and property at sea due to the wrecks of what are known as "tramp" steamers. Tramp vessels are those having no fixed sailing routes, but depending on shipping cargoes from any port to any other port and there again securing a cargo which will yield a profitable monetary return. In some ports they are disappointed in securing cargoes and have to make long trips in ballast. Often the ballast is quite expensive, as it represents considerable labor cost for the mere handling, to which often must be added charges for the material even if nothing but broken rock. Under such circumstances many commanders take on board only enough ballast to submerge the propeller to about half its depth. The result is that the propeller thrashes the water in a manner that is very destructive to the shaft and the adjacent plates of the vessel. The continual bending strain caused by a partially submerged propeller will eventually break any shaft whether large or small and whether made of the best steel or ordinary wrought iron. The only difference found in the materials composing the shaft or its size, is that the time limit for the best materials and larger shafts is longer than that for the weaker ones.

Almost all countries now have maritime laws prohibiting the sailing of all vessels loaded beyond a certain water line, as it has been found necessary to have such laws to defeat the plans of unscrupulous parties who would not hesitate to dispose of ships and cargoes to the maritime insurance companies by loading their vessels excessively so that they would be likely to founder in the first storm encountered. A law which would also prohibit the sailing of all steam vessels without sufficient lading to immerse the propellers, is equally as needful, as the dangers of wreck and loss in mid-ocean from failure of the machinery, are nearly, if not equally, as great as those arising from excessive cargoes.

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A CHANCE FOR GREATER USEFULNESS.

The departments of experimental engineering in the various colleges and technical schools have been developed to such an extent that they are prepared for any of the problems in mechanics that are capable of solution through experiment. With so many well-equipped laboratories, all of them doing good work, it is evident that there is the opportunity for a large amount of investigation that would be of great value to engineers, designers, etc. As a matter of fact, however, the results of their experiments are not available to any such extent as they ought to be. There is no certain and regular channel through which the results of tests can be reported and while they are sometimes brought to light through the proceedings of the engineering societies or through the publications of the colleges themselves, most of them are never heard of at all.

In the next place, many of the experiments are practically duplicated in the different laboratories. While this is necessary to a certain extent, because of the educational value of certain standard tests, it is apparent that there must be considerable waste energy in conducting special tests so long as each laboratory works independently of the others and in a measure duplicates their work. Few laboratories, moreover, can undertake to carry a series of experiments to completion within a reasonable length of time and their work therefore lacks the completeness that is to be desired.

The work of these laboratories, we would suggest, measured by its practical utility to the engineering public, could be improved by arranging for concerted action, so that a number of laboratories throughout the country could be engaged in different phases of the same subject at the same time. After a suitable interval these results could be collated and prepared for convenient reference. This method of working should be arranged by mutual agreement as to subject, system of testing, etc. so that no tests would be duplicated and the results would be comparable.

A better plan, however, might be for the American Society of Mechanical Engineers to appoint a committee to lay out a series of tests of general utility and arrange the details for its successful prosecution. The committee could then invite the colleges having suitably equipped laboratories to conduct some part of the series of tests, if they cared to do so; and it is safe to predict that the chairman of the committee would be able to present one of the most valuable papers that has been published in the proceedings of the society. It would be a paper that would arouse an unusual amount of interest because of the large number of people personally interested in it and it would, in our opinion, do as much as any one thing to bring those who are inclined to be sceptical about technical schools into full sympathy with them.

If such papers, covering their subjects with a fair degree of completeness, were presented from year to year, they would increase the value of the society's publications more than several papers containing reports of tests upon different branches of different subjects. The papers would be looked forward to by many readers and would be carefully preserved by them.

It is generally admitted that in educational work it is better to take a student through one subject thoroughly than to give him a smattering of many. The same principle holds in disseminating information among the public. It is better for them to have complete information upon one subject, in convenient form for reference, than for them to be obliged to seek for information from several sources, and then find, perhaps, that the available information is still incomplete.

AMONG THE SHOPS.

A FEW SNAP SHOTS, PHOTOGRAPHIC AND OTHERWISE, OF THE HAMILTON MACHINE TOOL COMPANY'S WORKS, HAMILTON, OHIO.

ARTHUR LETHERBY.

One whose vision and experience have been centered east of the Allegheny Mountains and who has been taught to believe that "Whatsoever things are true, and right, and of good report" in machine tool construction must be necessarily rooted and grounded in "Yankeedom" (and there is a good deal of truth in that creed) is pleasantly surprised and possibly benefited by a leisurely trip, commencing at Pittsburg and following, not too closely, the Ohio Valley. Here he may witness the virile growth of many modern manufacturing plants that have sprung into existence during the last decade or so, as well as some very fair specimens of what I think "Chordal" calls "shopitecture," some of which have been illustrated in this valuable paper from time to time. Time would fail me, however, to write of the many modern shops that are to be found in what is known as the Cincinnati district, and of which Hamilton is no mean factor, or of the many excellent productive organizations therein. What brief space I have to consume is to be used in a short sketch of the Hamilton Machine Tool Works, and while it is not presumed that anything new will be noted, still something of interest may be developed that may be useful to the young "technic" who has "hitched his chariot to a star" and might possibly overlook some such mundane things as a well kept casting shed; and yet it is a fair guess that such a shed would save him much more nervous force than a knowledge of the equation of the planets in his position of foreman or superintendent.

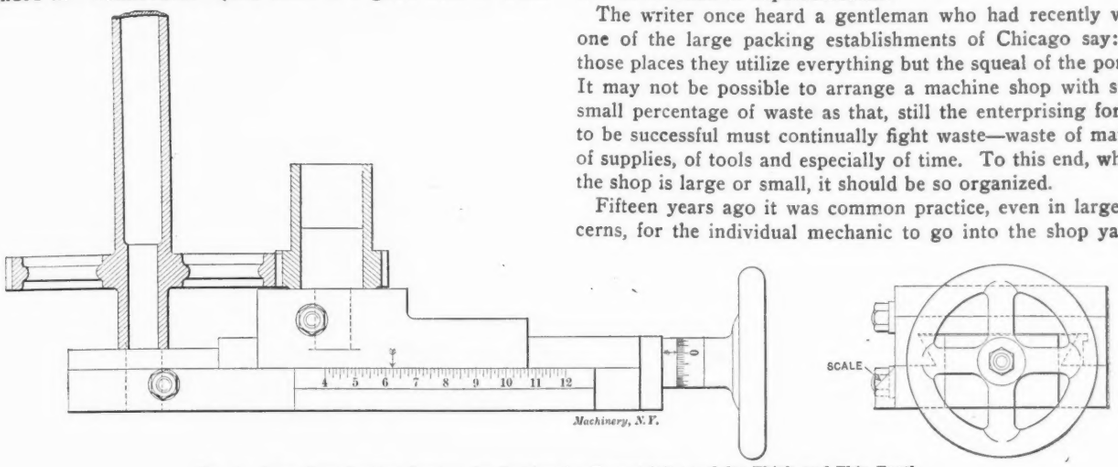


Fig. A. Spur Gear Testing Device, for Testing for Eccentricity and for Thick and Thin Teeth.

The writer once heard a gentleman who had recently visited one of the large packing establishments of Chicago say: "In those places they utilize everything but the squeal of the porker." It may not be possible to arrange a machine shop with such a small percentage of waste as that, still the enterprising foreman to be successful must continually fight waste—waste of material, of supplies, of tools and especially of time. To this end, whether the shop is large or small, it should be so organized.

Fifteen years ago it was common practice, even in large concerns, for the individual mechanic to go into the shop yard or cleaning shed and sort out the parts he required, put on his initials with a piece of chalk and try and work up a "stand in" with one of the helpers to deliver the same to his lathe or planer as the case might be.

All this go-as-you-please method is now done away with and various plans are adopted for the distribution of raw material. Our plan is briefly this:

When castings come in from the foundry, they are first weighed in bulk as so many thousand pounds received that day, and credit given the foundry or foundries as the case may be. They are then assorted by the man in charge and checked up to see if the order is delivered in full. Any shortage is noted and a memorandum given the head stockkeeper, who then compares it with the foundry list and notifies them of such shortage. If the castings are not immediately required in the shop, they are placed in bins properly labeled and the number of pieces marked on the face of the bin, as for instance: E. L. 263-29, which, translated, would read, Engine Lathe, pattern number 263, 29 pieces. The size and style of the machine is denoted by the pattern number, each machine taking the number between given limits; for instance, 14" Lathe 0 to 200, 16" Lathe 250 to 450 and so on. Upright drills are denoted by pattern symbols L. and L. L., radial drills by R. D., sensitive drills by S. and so through the entire line. Thus at a glance the stockkeeper or foreman can tell just what pieces are complete for a given lot of machines and order them delivered accordingly. It is obvious that to profitably manufacture tools in lots of from 50 to 150 a large stock of raw material must not only be carried, but the different parts must be machined at the one setting up of the machine tool, as

THE HAMILTON MACHINE TOOL CO.

STOCK-KEEPER:—

Please furnish .....

with .....

.....

.....

and charge same to Lot No. .....

Date ..... **Foreman.**

Received the above material;

(10m 10-1-99) .....

Fig. B.

Lot No. _____ *Job No.* _____

THE HAMILTON MACHINE TOOL CO.

Workman _____ *No.* _____ *Started* _____

SYMBOL.	Part Number.	NAME.	Number Wanted.	DATE AND HOURS.	Total Hours.	REMARKS.

Finished and approved. Date _____ *Price allowed for entire job $* _____

_____ *Foreman.* *Profit $* _____

Fig. C.

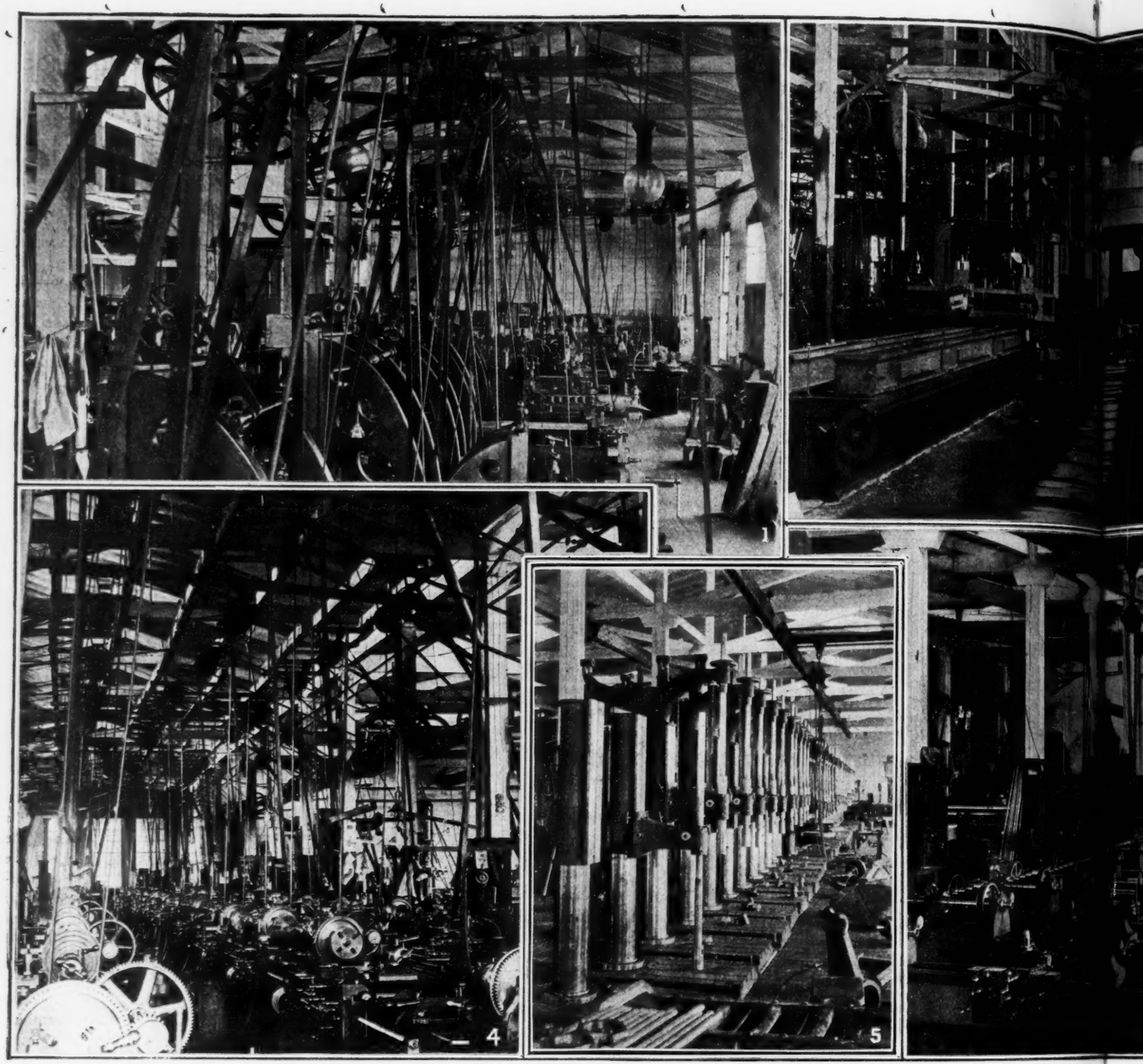


Fig. 1. Planing Department, with gear cutting and milling machines in the background. The planers are served by a tramway and small planers or shapers are placed between the larger tools, facing a strong east light.

Fig. 2. Main aisle, showing 31-ft. planer planing six 18-inch x 10-ft. lathe beds in foreground on the left. This view was taken with a wide angle lens and does not give a correct impression of the length of the shop.

Fig. 3. Stock Room. Size 43 ft. x 30 ft., contains 800 compartments; central rack extends from floor to ceiling; upper compartments reached by central stairway and gallery running around the room.

Fig. 4 Lathe Department, showing arrangement of tools to economize floor space.

VIEWS FROM THE HAMILTON MACHINE

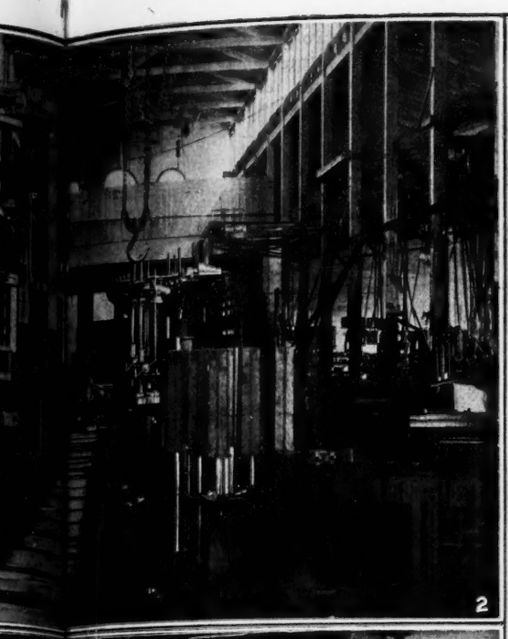
otherwise nothing much is gained in time and a large stock of raw material is carried without any compensation.

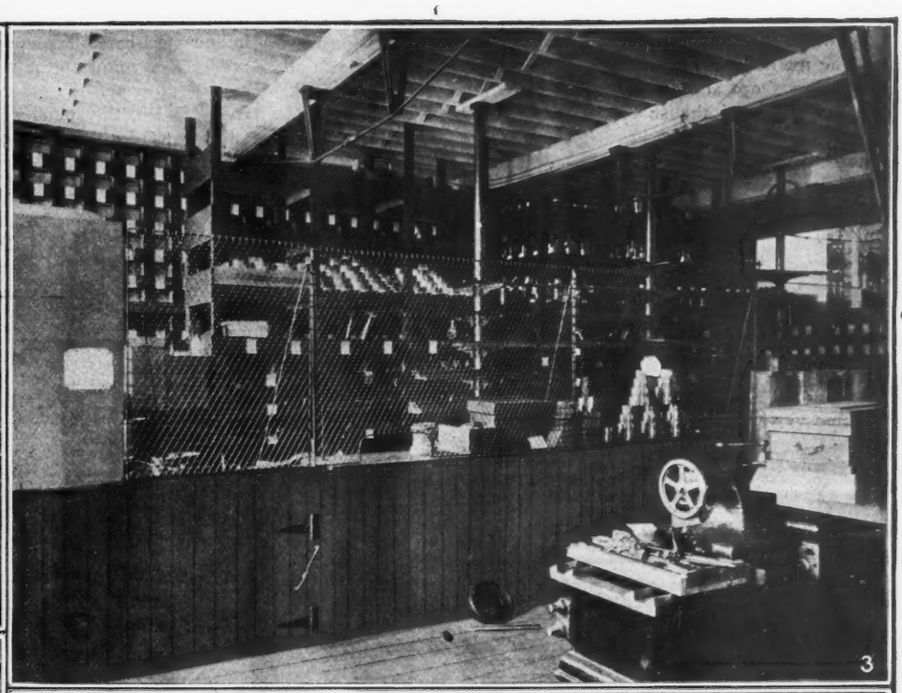
The machine tools in these shops are arranged in departments. The turning, chucking and flat turret lathes. as will be seen by the photographs, are laid out in three long lines the full length of the shop and placed as close together as possible. Arbor presses are placed at short intervals so that very little time is lost in removing work from arbors and the old practice of "touring" the shop to hunt a sledge-hammer and blocks is relegated practically to the past. All the planing, shaping and slotting tools are placed in a double row so that work of that class is all kept together. The planes, as will be noted, are served by tramway for all loads to 1,200 lbs. This is a very desirable feature for rapidly handling medium-weight pieces. Heavy pieces, of course, require a traveling crane.

Gear- and rack-cutting and milling forms another department. In this will be noted among others: Brown & Sharpe, Fellows, and Gould and Eberhardt gear cutters and Garvin millers. The Fellows gear shaper attracts a good deal of attention from visitors on account of its novel mechanism. A gear testing machine and cutter grinding machine are necessary tools in this department. The gear testing device is shown in Fig. A and needs no explanation. The erecting floor is well lighted from the roof and side and is provided with overhead traveling cranes and tramways so that work may be expeditiously handled.

A full line of drill presses, from sensitive to radial, is arranged contiguous to the line shaft and takes care of the drilling.

The pattern and drafting rooms occupy the second floor. The drafting room is well lighted with a northern exposure and fitted out with removable board tables and parallel ruling devices. Auxiliary tables fitted with drawers for the reception of data sheets, memoranda, instruments, etc., add to the convenience of the room. A large cabinet, properly labeled, tells at a glance where to find the proof folio for a given machine.





Figs. 5 and 6. Erecting Floor, illustrating the general method of assembling lathes and drills. This floor is well lighted from both the sides and roof. A number of electric call buttons connected with an annunciator in the tool room, and the ubiquitous small boys commonly known as "tool-monkeys," maintain the tool service of the department.

Fig. 7. Casting Warehouse. Subdivided on the same plan as stock room; central steel rack extending from floor to ceiling; railway switch sunk to bring car floor level with warehouse floor, so as to facilitate the rapid unloading of cars; sliding doors are spaced so as to accommodate three cars at one time, the doors sliding behind casting compartments.

LTON MACHINE TOOL COMPANY'S WORKS.

The stock room for finished parts acts as a sort of clearing house between the machine and erecting departments, and is an invaluable receiving, checking and distributing center for the one-hundred-and-one small parts that enter into a lot of tools. Our method of following up a given piece of work may be illustrated by taking some piece and tracing it from the casting shed to the shipping platform. We will take a spur gear, say for fifty machines. The foreman goes to the casting shed and notes that there are 55 pcs. L14, and gives the man in charge an order like that in Fig. B.

He takes them from the bin, weighs them, and charges their weight, say 281, against the lot. They are then delivered to the chucking lathe and the operator receives a piece work card (Fig. C) for his operation and a transfer card (D) is placed with the castings and is receipted for by the operator, Smith. After boring, facing and reaming they are passed on to the engine lathe, where Brown receipts to Smith for 50 pieces and finishes them up complete, except polishing. They are then polished by Fiske and sent to the gear room. After Hall has cut the teeth they are taken to the stock room, inspected and accepted and then are held subject to the final order of the erecting foreman, which cancels the card and accounts for every piece worked upon.

Of course, there are always a certain number of defective castings or pieces with poor workmanship, and this is traced and taken care of upon the accompanying blank form (Fig. E), which, after scrutiny by the superintendent, is forwarded to the stockkeeper to replace the parts thrown out. It will be understood that this system applies principally to small parts, and is very little trouble after it is once installed.

The daily time cards (Fig. F) are collected from boxes placed conveniently about the shop, before eight each morning, and are countersigned by the foreman of each department. They are then entered upon a weekly slip and finally upon the cost book.

The total number of hours per day is corrected to conform to the tape from the clock register.

The methods of manufacture are pretty much the same in all first-class shops and are controlled largely by the means placed in the hands of the superintendent or foreman. Figuratively speaking, no man can make "bricks without straw" now, any more than he could in the time of Moses; therefore, it is fairly axiomatic that given good tools and good men, good work will be the result. The writer remembers that back in the seventies, when running a flat-shear gap lathe, he was requested to turn a piece of shafting, and it was necessary when approaching the gap

THE HAMILTON MACHINE TOOL CO.

Lot No. 281 No. Pcs. 50

Part No. I 14

Name Top shaft gear

The Lot No., No. Pcs. and Part No. or Name must always be given on the time card.

TRANSFER CARD

DATE	No. PIECES RE'CD	RECEIPTED BY
4/16/00	50	W. Smith
4/19/00	50	G. Brown
4/26/00	50	P. Fiske
4/27/00	50	G. Jones
4/31/00	50	Phillips, S.K.
5/9/00	50	J.W.F. O.K.

(5m-11-15-99)

Fig. D.

to incessantly caliper with his right hand while with his left he tapped the cross-feed crank to overcome the deflection of the carriage. To expect a man to use micrometers on a machine tool of this description would be absurd and to hold him down to from one to three-thousandths of an inch, folly, and yet this was not in "Jones'" shop either.

THE HAMILTON MACHINE TOOL CO.

DEFECTIVE MATERIAL CARD.

Lot No. 281

No. of Pieces 2

Part No. EL 27

Name of Part Cone pinion

Cause Error of workman.

Hours Labor ½

Workman Reporting W. Black No. 47

Date 5/14/00

Approved H. J. Foreman.

Fig. E.

We endeavor to give our men good tools and then we feel we have a right to expect good work and plenty of it, and it gives me pleasure to say that our men generally "rise to the occasion." It therefore follows that all spindles are ground to standards, that the phosphor bronze journals are carefully fitted to the headstocks of our lathes and that great care is taken to insure perfect alignment. Our method of proving is to insert a hollow steel bar in the spindle. The bar has two collars upon it, accurately ground to the same diameter; one located close to the spindle nose, and the other at the end of the bar. After this bar is inserted in the spindle, an indicator is placed in the tool-post and arranged to reach both the sides and top of the bar. By moving the carriage along, the deflection in thousandths either

TIME CARD.

THE HAMILTON MACHINE TOOL CO.

LOT NO. 281 DATE 5/14/00

WORKMAN W. Black NO. 47

NO. PIECES	SYMBOL AND PART NO.	OPERATION.	NO. HOURS. PIECE WORK	NO. HOURS. DAY WORK.
50	EL 27	Gear Cutting	9½	
				½
APPROVED,	H. J.	FOREMAN.	TOTAL	10

NOTE.—Do not place more than one Lot No. on each time card. Use separate cards for different Lot Nos.

Fig. F.

way may be noted and corrected. To insure that the journal is round, or that the taper hole is central, the spindle is rotated and the fluctuations of the needle noted. In this case it must be remembered that the actual error is just one-half that indicated. I may say these bars are from 18" to 30" long.

Other bars with cast-iron collars pressed upon them are inserted in the spindle and a cut taken over them, the micrometers applied and variation noted. But, not to be tedious over well known methods, I would say with Bobbie Burns, "The best laid plans of mice and men gang aft aglee," and that only in ceaseless vigilance is perfection found.

THE HAMILTON MACHINE TOOL CO.

Name of Workman, *John W. Smith.*

Time for Week Ending *May 25, 1900.* *23 1-2*

Kind of Work, *Lathe Work.* Workman's No. *76.*

Lot No.	Sat.	Mon.	Tues.	Wed.	Thu.	Fri.	Total Hours	Amount.
275	3	4¾	.....	.....	.....	½	7¾	1 82
264	.....	¼	.....	4	.....	¾	5	1 18
Special	.....	½	2¼	.....	.....	.....	2¾	 64
283	2¼	5¾	.....	.....	.....	4	11½	2 71
272	.....	.....	4¼	.....	.....	1¼	5½	1 29
Stock	.....	.....	3¾	1¼	9½	.....	14½	3 42
Gen. expense	.....	.....	.....	¾	.....	.....	¾	 17
266	2½	.....	.....	4¼	.....	.....	6¾	1 58
285	.....	.....	.....	.....	¾	.....	¾	 18
287	.....	.....	.....	.....	.....	3	3	 71
284	1	.....	.....	.....	.....	¾	1¾	 40
.....	.....	.....	.....	.....	.....	.....	.....	....
Total							60	14 10

Fig. G.

Carefully designed jigs and templates fitted with ground steel bushes assist in the rapid duplication of parts, and standard plugs and limit gages hold internal diameters where they belong. Drive, tight, loose and running fits should always be made on the shaft or stud.

But I am afraid my patient readers may think these "Snap Shots," unduly "exposed," so close by extending a cordial invitation to visit our works.

* * *

Leslie's Weekly makes a statement which forcibly shows the effect of labor-saving machinery when it says that the Chinese are a nation living in brick houses in a land without a brick-making machine. All the millions of homes in the thousands of walled cities are built of brick, and every brick made by hand. These bricks are made by labor costing but ten cents per day, still they cost more than our machine brick made with labor costing twenty-five times as much.

MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION,—9.

LATHE ATTACHMENTS.

W. H. VAN DERVOORT.

The use of special attachments on the lathe frequently makes possible the machining of work that could not otherwise be accomplished on this tool. This was in a measure illustrated in the method shown in article 8 for the turning of spheres and cams. The following examples will serve to show a few attachments which will often be of great value, especially in shops having limited equipment, and where the lathe must often do the work of milling machine, boring mill or shaper.

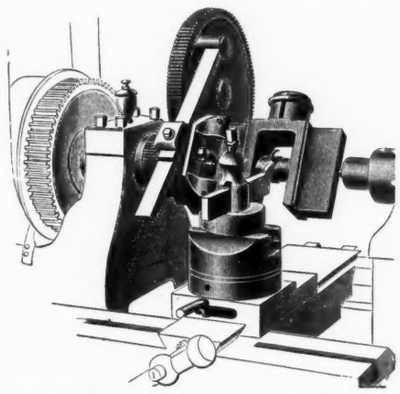


Fig. 76. Cross-head Pin Turning Attachment.

In Fig. 76 is a patented device used on the lathe for the turning of cross-head pins or other surfaces the nature of which prevents the possibility of complete rotation of the work. In this device a sleeve carrying two gears is secured on the nose of the lathe spindle. The gear next to the spindle bearing is keyed to the sleeve and rotates with the spindle. The second gear which carries the work driver rotates freely upon the sleeve. The first gear meshes with a larger one that is carried on a bracket secured to the back of the head stock. A wrist pin in the face of the large gear drives the rack which, as shown, gears with and drives the loose gear and thus causes the work to rotate independent of the spindle rotation. By properly proportioning the diameter of the gears and the stroke of the rack, the work can be made to oscillate back and forward through any desired part of the revolution, while the spindle has continuous forward rotation. Thus in the turning of the cross-head pin shown, the

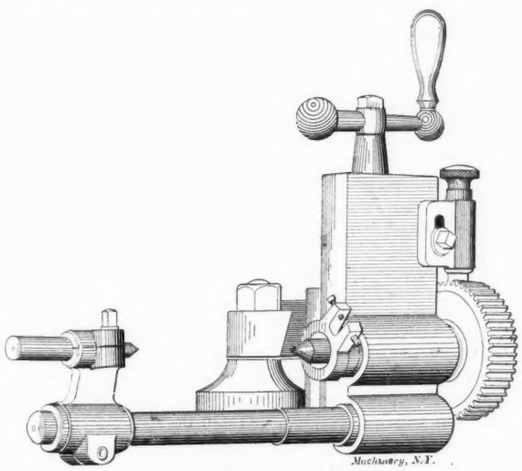


Fig. 77. Lathe Milling Attachment.

cross-head moves through rather more than one-half of the full revolution, thus enabling the turning of a little more than one-half of the pin. The cross-head is then changed end for end on the centers and the other half turned. Frequently, with cross-heads to be used in single acting engines, where the pressure and wear are always on one side of the pin, a large flat can be machined on the non-bearing side of the pin and sufficient rotation obtained to completely finish the pin without changing ends with the work. It is, of course, possible to turn a pin of this character without any special attachment, by either pulling the belt backward and forward and driving the work in the ordinary manner or by allowing it to rotate free on the centers and oscillating it by means of a wrench or lever. These latter methods are slow and require an extra workman.

Fig. 77 serves to illustrate a class of attachments that can be advantageously used for performing milling operations on the lathe. The attachment shown is secured to the tool block in the place of the tool post. The construction is such as to provide for suitable vertical adjustment, and the milling cutter to be

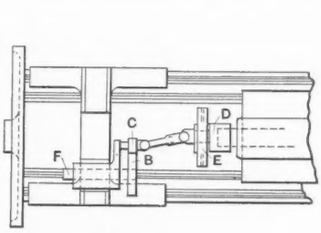


Fig. 78.

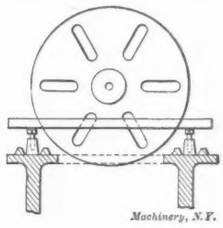


Fig. 79.

used is carried on an arbor held between the lathe centers. The attachment shown is suitable only for light milling operations, as it is not sufficiently rigid for heavy work. An attachment constructed along the same lines and attached to the carriage in place of the cross-slide can be made sufficiently rigid to enable heavy work to be done upon it and will, in the absence of a milling machine, be found a most useful device. If it is required to bore a hole in a piece of work parallel to another hole that has been bored in the lathe, it is necessary to offset the work until the required bore is concentric with the axis of rotation. This involves very accurate chucking, and if the work is large, the swing of the lathe will frequently not permit sufficient offset. When enough work of this character is to be done to warrant its construction the attachment shown in Fig. 78 will be found very satisfactory. Its construction is simple, consisting of a suitable bearing that can be secured to the tool block and carrying a spindle or boring bar. A pulley for driving the bar can be attached directly to its outer end, or if the amount of use the attachment is to be put to will warrant it, it can be constructed as

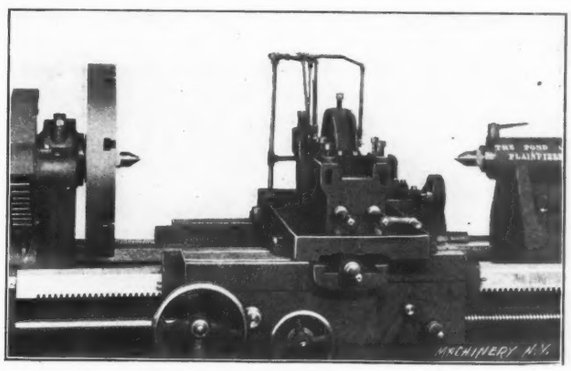


Fig. 80. Shafting Turning Attachment.

shown in the figure. The spindle in this case is provided with a taper bearing at F to receive a taper shank drill, an end milling cutter or a short boring bar. The outer end of the spindle carries the gear B; gear C meshes with B and is carried on a radially adjustable stud. Gears B and C should be made to interchange or even be replaced by others, and thus provide for changes of speed on the spindle. The driving pulley E is carried loose on a suitable stud D, which clamps over the nose of the tail spindle. A pair of universal couplings with a telescoping shaft connects E and C and transmits the power. In the operation of this attachment belted power is transmitted to E and to the regular lathe feeds used for advancing the cutter to the work. The face plate must be blocked to prevent the work from turning. In Fig. 79 is shown a satisfactory method of blocking the face plate and, at the same time, of providing an adjustment for accurately locating the position of the bore. An attachment of this kind will frequently be found quite valuable

as, for example, in the boring of a crank disc for shaft and crank pin, the attachment boring the hole for the pin with reasonable certainty of getting it parallel with the bore for the crank shaft.

In Fig. 80 is shown an attachment secured to the carriage of an engine lathe for turning shafting. With this device the shaft is roughed down by two tools set opposite to each other, which serves to balance the pressure of the cut and reduce the spring to a minimum. After the roughing cuts, it passes through a suitable bushing held in the head and receives the final sizing and finishing cut from the tool shown at the back of the attachment. The device is simply a follow rest carrying three tools instead of one.

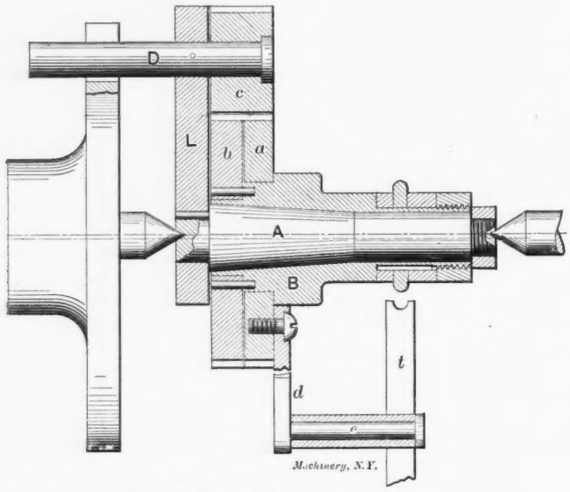


Fig. 81. Device for Backing-off Cutters.

An ingenious patented lathe attachment for backing off of the teeth of milling cutters is shown in Fig. 81. In a device of this character either the tool or the work must be given a slight in-and-out motion for each tooth on the cutter being relieved. In the case shown, the tool is held in the tool post and advanced to its cut in the ordinary manner. The mandrel A of the attachment has its centers slightly eccentric, the amount of the eccentricity being enough to produce the desired amount of relief on one tooth of the cutter if mounted directly on the mandrel. The arm L is secured to the mandrel and driven from the face plate by the carrier D. The sleeve B, which carries the cutter being operated upon, revolves freely upon the mandrel. The gear b is secured to the sleeve and the gear a is loose on the sleeve, and is held from rotating by the arm d which is secured to it and rests upon the top of the tool; c is a pinion carried loose on the stud D and gears with a and b. Gear b has a smaller number of teeth than a, and as a does not rotate, the

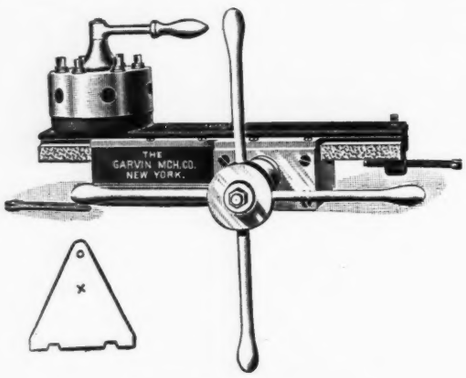


Fig. 82. Automatic Turret.

rotation of the pinion c around a advances b and the sleeve and cutter a certain fixed amount at each revolution of the mandrel. The geared ratio is such for any given number of teeth in the cutter that the advance per revolution is exactly equal to the circular pitch of the teeth in the cutter. The turning is such as to bring a tooth to the tool when the center of the mandrel is farthest from the tool, thus giving the relief as the tooth advances to the tool. It is evident from the above that the space between the teeth must be at least equal to the length of the tooth. As this division of space and tooth in relieved milling cutters is not usual, it is necessary to allow the cutter blank to stand still while the mandrel is moving through a part of its revolution. This is accomplished by making the circular pitch of the teeth on about one-half the circumference of b equal to that of the teeth on a and the teeth on the balance of b of somewhat greater circular pitch. For that portion where the teeth are the same on a and b, the pinion simply turns around both

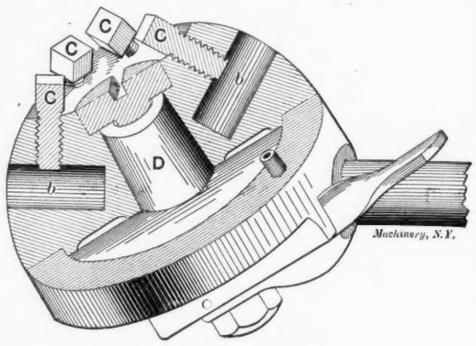


Fig. 83. Tail-stock Turret.

and the sleeve remains stationary. During the balance of the revolution, however, the sleeve will advance an amount equal to the circular pitch of the cutter's tooth.

In Fig. 82 is shown what is known as a turret attachment, which may be applied to the ordinary engine lathe in place of the tail stock, or on the carriage in place of the tool block, a somewhat different design being required for each application. A third and still simpler application is shown in Fig. 83, where a small turret head is applied to the tail spindle of the lathe. In construction the turret is simply a revolving head provided with a number of holes in which the tools to be operated are secured by set screws. These holes are axially true with the line of the centers, and the turret can be rotated so as to bring each of the holes successively into the line of centers, a suitable lock and clamp holding it in each position. In the simpler forms, the turret is rotated and locked by hand while in the class known as the automatic and illustrated in Fig. 82, the turret slide is operated by the turnstile, the mechanism being such that the

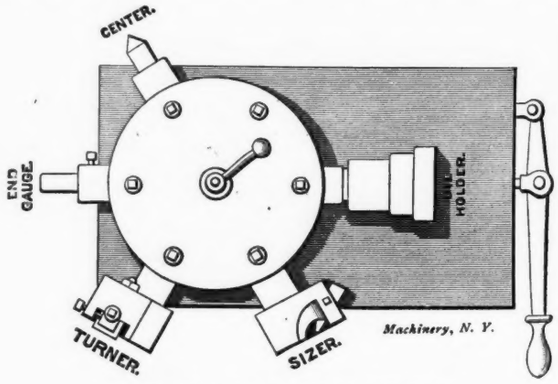


Fig. 84. Plan View of a Turret, with Tools.

head is rotated through one division by the last portion of the slide's stroke in carrying it back from the work. The turret slide for the smaller sizes is usually operated with a lever, and, when used for facing operations, is provided with a cross feed operated by hand. The advantage of the turret attachment is due to the rapidity with which different tools can be brought into action on work requiring a variety of operations. Turret head operations are confined almost entirely to chucked work and can be economically employed only when a number of similar pieces are to be machined. From the plan view of the turret head shown in Fig. 84, the several operations in an important application—that of making a machine screw—are clearly shown. The end gage determines the length of stock to extend from the chuck. The turner reduces the stock to nearly the exact size. The sizer takes the finishing or sizing cut and the die runs the thread, all of the operations being performed with much less loss of time

in changing from one tool to another than would be the case if the same work were done in the common engine lathe.

As a large percentage of lathe work is held in the chuck and requires only short tool travel, classes of lathes for this character of work, with short beds fitted with turret heads and known as monitor and chucking lathes, and screw machines, are made. Fig. 85 illustrates a monitor lathe. The turret slide is operated with a lever or screw and provided with a cross adjustment for facing. A suitable stop on the cross shear enables the turret to be readily brought back to a central position. These lathes may

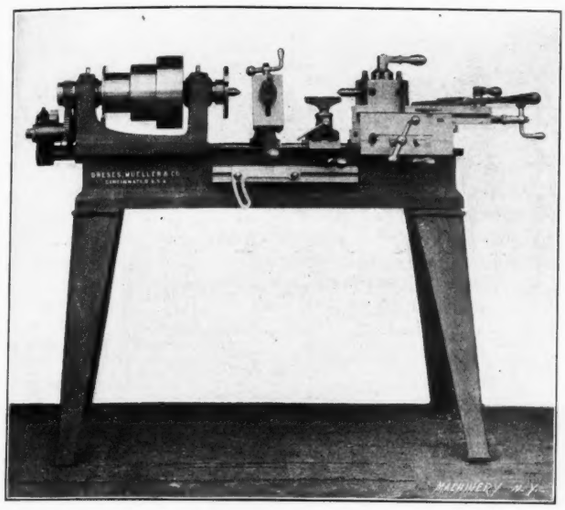


Fig. 85. Monitor Lathe.

be made either with or without back gears. The inclined chaser head, which carries an inverted tool used for forming, boring and threading, is carried on a rigid chaser bar mounted on the rear of the bed. The bar slides endwise and also rotates in its bearings, thus allowing the head to be turned back out of the way when not in use. For threading purposes, the end of the chaser bar carries what is known as the "follower," which engages the threaded "leader" shown at the left of the head stock. The leader may be of any desired pitch and need not be long, as the character of the threads cut does not require it. As many of the

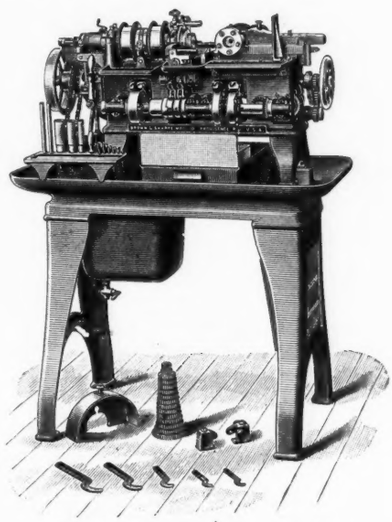


Fig. 86. Automatic Screw Machine.

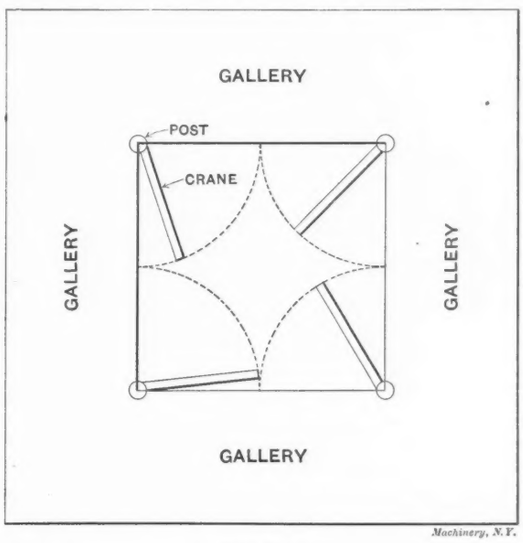
threads cut in a lathe of this class are pipe threads, some provision must be made for cutting them on a taper. In the machine shown, the lever rest on the front of the lathe will, when set at an angle with the top of the shears, throw the lever and tool out as it advances over the cut, thus producing a tapered thread. By raising the lever at the end of the cut, the follower is disengaged and the tool can be quickly returned for another cut, being adjusted to its cut in the ordinary manner. These lathes are usually furnished with a simple tool rest for hand turning. The chaser head can be used for cutting-off pu-poses. A cut-off tool can be held inverted in rear tool post and a chamfering or rounding tool held in the other. A forward motion to the lever brings the cuttting-off tool into action. After the work is cut off the chamfering tool is brought into action by an outward motion of the lever. The monitor lathe is strictly a brass finisher's lathe and very largely used upon all classes of valves and fittings.

The screw machine in its simple form differs but little from the monitor lathe here described, as it cuts its threads with a die. The chasing head and bar are omitted, and, as its work is all done over the end of the stock, a cross adjustment to the turret is not necessary. The hollow spindle is fitted with a draw-up chuck at its nose and steady chuck at the rear for holding the stock, these chucks being quickly operated by means of a lever. The wire feed for advancing the stock the proper amount for each setting is now quite generally employed. The full automatic screw machine, while embodying the same general principles, has in the developing of its automatic features become so completely disguised as to almost lose its identity as a member of the lathe family. In Fig. 86 is shown a view of the full automatic screw machine. With machines of this class it is simply necessary to keep them supplied with stock, one man watching a number of machines without difficulty. It should be understood that the screw machine while designed for the manufacture of machine screws is capable of doing a very wide range of other work.

[Of the illustrations in this article, that of the cross-head pin turning device was kindly furnished by B. J. Coates, Erie, Pa.; of the automatic turret, by the Garvin Machine Co., New York; of the automatic screw machine by the Brown and Sharpe Mfg. Co., Providence, R. I.; and the illustrations of the shaft-turning device and of the monitor lathe are from photographs furnished by the Pond Machine Tool Co., Plainfield, N. J. and Dreses, Mueller & Co., Cincinnati, O., respectively.—Editor.]

* * *

The machine shop building of Houston, Stanwood & Gamble, Cincinnati, builders of steam engines, cannot be classed as modern, for it was put up many years ago. It is, however, an interesting structure from the fact that, although dating from before the time of traveling cranes, it contains a number of modern features that make it well adapted to the work that is done within its walls, even at this advanced time when new and modern shops are generally considered so essential. The accompanying diagram is a rough sketch of the floor plan. The building is square,



Floor Plan.

or nearly so, and has a gallery around the four sides for small machine tools, fitting, etc. The main floor is served by four jib cranes turning on posts at the inner corners of the galleries. These can reach nearly all parts of the erecting floor, which is the central part of the shop, not covered by the galleries, and open to the roof. The large tools are placed either wholly or partly under the galleries and are easily served by the cranes. The shop is lighted by side windows in the walls and also by windows in the roof, which is of the monitor type. The ideas embodied in this shop building may prove suggestive, even to builders of new shops.

LETTERS UPON PRACTICAL SUBJECTS.

A SILENT CONDENSER OF STEAM UNDER WATER.

Editor MACHINERY:

One of the most annoying sounds that frail humanity has to endure is the noise made from "water-hammer," created by steam being blown into a fluid to heat it, or to condense the vapor from wastes. The vibration from this hammering not only wrecks the nervous system of those who are compelled to be in its neighborhood, but it starts almost every joint to leaking in the system of pipes to which it is connected, which causes many delays and unnecessary expense in making repairs. As this often occurs in the many processes of manufacture, there are many sufferers from this cause. To obviate this trouble, I herewith submit an arrangement, which I hope will be of interest to the readers of this journal and of some practical service to those who are suffering from this nuisance.

The simplicity of construction of this device places it within reach of any ordinary mechanic, as it can be made at a very reasonable cost. It consists of a piece of brass pipe with countersunk perforations and a thread at each end to receive the locknuts and cap. One end is threaded longer than the other to receive the fitting, in making connections, as shown in Fig. 2. This arrangement is in the form of a spool, upon which is tightly wound alternate strips of burlap and fine-meshed brass wire gauze. The strips should be the width of the distance between the discs and the object of placing gauze with the burlap is to prevent it from being blown away by the steam. The outer casing of gauze is secured by means of angle pieces soldered or riveted to the edges and drawn together by means of bolts. Under this joint is placed a flat strip of metal so that the edges can ride without tearing the burlap. The brass pipe should be sufficiently long between the discs to receive enough perforations to equal twice the area of the steam pipe. The smaller the holes, the better the results obtained. The burlap and gauze are wound around the spool to a thickness of one and a half to two inches.

The steam in passing through this object, is exposed to an increased area of surface in comparison to the area of pipe, and its divisions, in passing through the burlap and gauze, are very minute; the steam rapidly condenses and imparts its heat to the surrounding fluid, and whatever of "water-hammer" occurs, cushions on the soft burlap, thus making a noiseless device for this service.

There are manifold purposes to which this nozzle can be applied, such as heating feed water in precipitating tanks, bathing pools, process kettles, or for any purpose where hot water is required and the absence of noise is a factor. It is an excellent terminal for bleeders and drains from steam traps which are led to tanks to save feed water and vapor from arising.

This noiseless condenser of vapor under a fluid will do all that is here claimed for it, and its application I leave to the ingenuity of the modern mechanic.

GEO. C. STANLEY.

Norfolk Navy Yard.

DEVICE FOR CENTERING CRANK SHAFTS.

Editor MACHINERY:

I send herewith a sketch of a fixture to be used for centering crank shafts.

Fig. 1 shows the shaft in its finished state. Stock large enough to make the shaft is taken, centered, faced and turned on each end to fit the fixture as shown in Fig. 2.

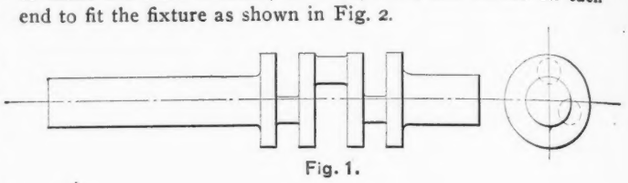


Fig. 1.

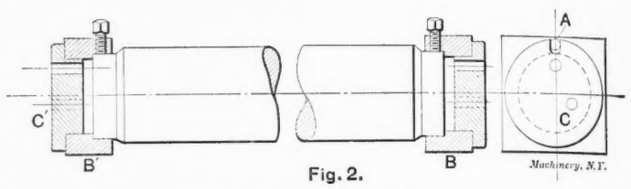


Fig. 2.

Centering Crank Shaft.

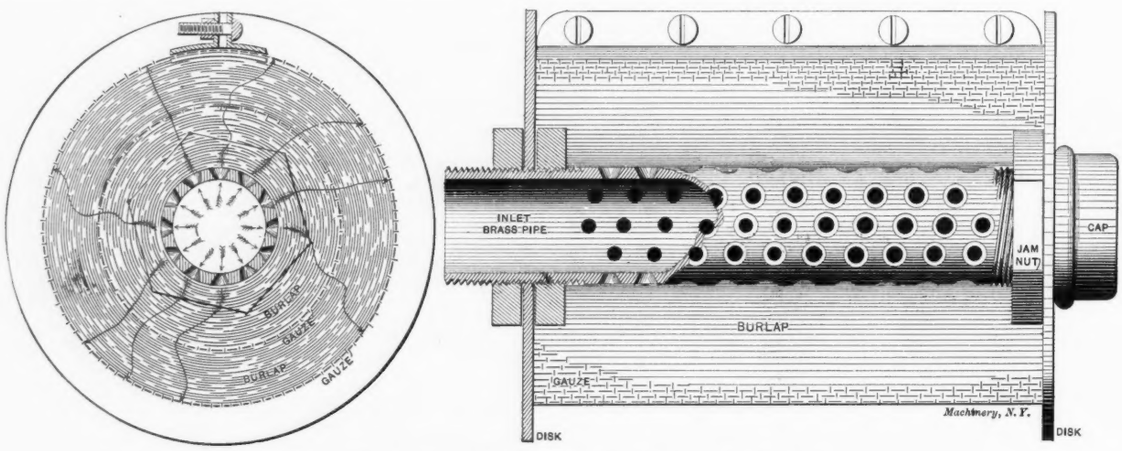
The shoulder in the main piece B of the fixture limits the distance to which the shaft enters. Fixtures are planed on the bottom and after being set on the platen, the shaft is put into the holes of the fixtures and then held by set screws for the centering operation.

The holes in the steel piece C, which fits in the other end of the fixture, are made to fit a combination center drill and countersink, so that both results are accomplished in one operation.

The piece is made removable so that other pieces may be fitted for different work. These are brought into line by means of the pin A shown in the end view.

A. A. B.

Hartford, Conn.



Figs. 1 and 2. Silent Condenser for Steam Escaping Under Water.

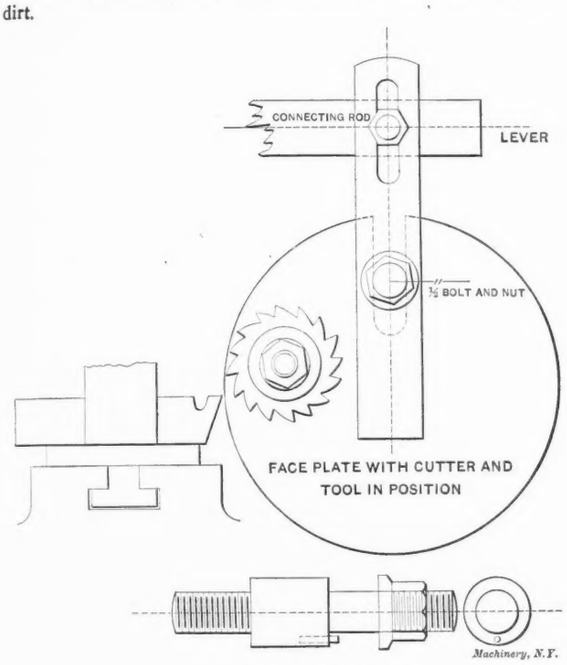
"HOW AND WHY."

Editor MACHINERY:

In answer to question 54 in May issue of MACHINERY, would say that the following receipt can be used to brown gun barrels: Spirits of wine, 1½ ounce; tincture of iron, 1½ ounce; corrosive sublimate, 1½ ounce, sweet spirits nitre, 1½ ounce, blue vitriol, 1 ounce, nitric acid, ¾ ounce. Mix and dissolve in one quart warm water and keep in a glass jar. Clean the barrel with a hot solution of caustic soda to remove all grease, etc., and polish bright with emery cloth. Stop the mouth of the barrel and also the vent with wooden plugs and be sure all finger marks are removed from the surface of the barrel. Apply the mixture with a sponge or rag and expose to the air for 24 hours; then rub the loose rust off with a steel scratch-brush and apply the mixture once or twice more if necessary. Wash in boiling water and rub down with boiled linseed oil.

To blue gun barrels, clean the barrel as stated before, dissolve 4½ ounces hyposulphite of soda in 1 quart of water, also dissolve 1¼ ounces of acetate of lead in 1 quart of water. Mix these two solutions together in a porcelain-lined vessel and boil. Warm the barrel and apply the mixture with a sponge or rag tied on a stick. When color develops, wash, wipe dry and finish with linseed oil. The barrel may be blued by heat but it takes considerable experience to do this. There are several other formulas for the above but I do not wish to take up time and valuable space. If desired, they can be obtained by a personal letter.

To cement leather to iron, the iron surface must be free from oil or grease, as also the leather. Steep ½ dozen of bruised nut galls in one quart of clean soft water, for about six hours. Take best glue and let it soak 24 hours in its equal weight of water; then heat and dissolve. Strain the nut gall solution and apply to the leather, which must be warm also. Have the pulley warm and apply the glue to the pulley and put them both together. The surface of the pulley should be slightly rough just as the tool leaves it and not filed. In cases where the surface is smooth and polished, rub it with a raw onion cut in halves, cover the surface thoroughly and let it dry. The glue adheres very firmly but in every instance all surfaces must be free from grease or dirt.



Backing-off Cutters.

I had a very bothersome piece of work to do recently. Two small 2" diameter cutters, one with 16 teeth and one with 14, had to be backed off twice the usual clearance, which meant 3-16". Now we have machinery to back them off the usual amount, but nothing to do anything near 3-16", so I had to back them off by hand. A center line was drawn across the face plate of the lathe and the position of the cutter was located so as to bring the tooth to be operated on within a radius which would give the desired backing off or clearance. A hole was drilled and tapped to hold the stud on which the cutter was to be held. This stud had a shoulder or collar as large as the clearance would allow and 1½" long, so as not to have the face plate or work conflict with any part of the carriage, etc. The shoulder also had a pin placed so that the cutter would always be in proper position when shifted from tooth to tooth. The stud was screwed into the face plate and the check nut brought up tight, for everything must be rigid in this operation. The cutter was put on and another collar or washer as large as feasible, and then the nut was screwed up tight.

The usual way of operating with this rig is to have a lever bolted on to the face plate and a stop so as to allow the cutter to travel just so far back and forth, but this is a rather tedious operation. This objection can be overcome if another lathe is near and parallel with the one in which the operation is to be performed. Slot the lever and put a crank-shaft in the other lathe. Connect both with a rather stiff connecting-rod and have the crank of the proper throw; when the lathe is started up it leaves the operator with two hands to manipulate the feed, etc. The crank-shaft can easily be made from any old piece of scrap, the right length being determined by the position of the lathes. One end is held in the chuck and the other in the steady rest. A pin driven in the end, when the proper throw is determined, forms a very good and cheap crank.

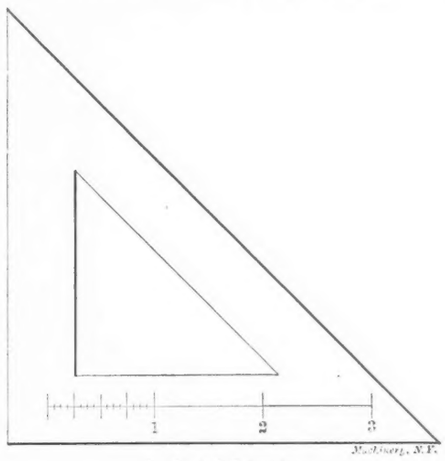
Dorchester, Mass. S. WRENCH.

* * *

DRAFTSMAN'S TRIANGLE WITH SCALE.

Editor MACHINERY:

If a draftsman will mark off a scale similar to that in the sketch on a celluloid triangle he will find it a great convenience in setting his compasses and dividers. If he will also paste a few pieces of card board about ¼ inch wide, 1-16 inch thick



Graduated Triangle.

and 2 inches long and at intervals of about 16 inches on the bottom side of his T square blade, he will find that his drawing will not get as badly soiled as when the blade lays perfectly flat on the paper.

C. C. R.

Greensburg, Pa.

* * *

THE CIRCUMFERENCE OF ELLIPSES.

Editor MACHINERY:

In the April issue on page 248 in the article by Henry Hess, "Circumference of Ellipses," he gives three formulas for computing the same.

The following formula has been used for some years, and is a nearer approximation than that of Nystrom or Molesworth, besides being much simpler.

Let a and b = the semi-diameters, then

$$\text{cir} = \pi \left(\frac{3\,(a + b)}{2} - \sqrt{a\,b} \right)$$

Brooklyn, N. Y. H. W. N. COLE.

* * *

PLANER FEED MECHANISM—FASTENINGS OF CROSS-FEED NUT.

Editor MACHINERY:

It appears to be a generally accepted fact among machine designers and draftsmen that friction feeds and drives are a desirable and essential feature to most any class of machinery. In this respect they should be encouraged, for the fact cannot be overlooked that the usefulness and effectiveness of this feeding device are daily increasing and will continue to do so for some time. It would seem, however, that friction feeds like all "good things" are pushed a little too far, not alone by the designer, but by the machine that pushes them along. It has always appeared ridiculous to me to see a 12′ or 16′ planer on full cut, dragging a friction disc feed 24′ or 32′, as the case may be, in order to move the feed gear two or three teeth. It is a clear case of "the tail wagging the dog" with a vengeance. That this style of feed gives entire satisfaction cannot be denied, and I suppose for this reason it is allowed to remain in its present form. But that this style of feed requires considerable power to overcome the friction when the planer is in motion, can be found by any one who will take the trouble to turn the tight pulley by hand with the feed disc

turning freely between striking poppets and then after the disc has struck the poppets. I have been frequently misled as to the cause of the sudden sticking, as it were, and invariably looked to see if the dogs were up against the tripper arm. No doubt, some of the readers will say that it was a clear case of a man with a monkey wrench and the adjustment within his reach, but it was not, for loosening up the binding bolts did not remedy the evil. It allowed the pulley to turn easier, but stopped the feed. This has been the writer's experience in numerous instances with different styles of friction feeds. It seems to me that if the designers took into consideration the amount of power necessary to sustain this device on a planer, they would certainly change it, or alter it in such a way that when the disc struck the poppets the friction would be released, as the feed only occurs between poppets. While I do not believe in retrogression, I think that the tripper arm feed should be given some consideration. I do not mean to employ the rod and fan gear feed, but an up-to-date affair with rack and variable feed. This would be the cheapest method for feeding, as the momentum of the table alone would be sufficient to send the tripper arm over. It would, however, be necessary to increase the thickness of the dog, slot and all parts of the tripper to commensurate for the increased work brought to bear on it.

The cross-feed nut on a planer head is a never failing source of annoyance on account of the manner in which it is secured. In the first place, the two little screws that hold it are sadly inadequate, especially when the tool is taking a side cut, and the whole force of the cut is brought to bear on the screws. I am well aware that in some planers recesses are cut into the back of the saddle for the nut to fit into and in others dowel pins are used. Still the screws and nut work loose. The remedy would appear to be in having the nut fastened from the rear of the saddle and using at least four good sized screws for fastening. To reach this a reinforced hole five or six inches in diameter could be put in the cross rail without weakening it. The nut could be fastened to the saddle through this opening and kept tight without having to take the head apart to reach the screws. T. B. C.

Brooklyn, N. Y.

* * *

CUTTING A KEY FROM THE SOLID—GROOVING ATTACHMENT FOR LATHE.

Editor MACHINERY:

A little wrinkle which may be useful to some readers of this journal, was made use of to good advantage on the following described job:

A brass sleeve shown in Fig. 1 required the key to be worked out of the solid. The sleeve was finished all over and a groove 1/16″ wide cut at A to a diameter of 2″. The sleeve A was then placed on one of the T-slots of a shaper as shown in Fig. 2 and clamped so that it could be easily turned by hand, yet have no shake. The clamp plate was screwed down tight on the distance pieces B B which may be made of anything that will answer the purpose. Plates were bolted to the shaper table at each end of the sleeve to answer as stops. The time required for rigging up and doing the job was only one and one-half hours. It will be noticed that it would have been practically impossible to have set a feather in the sleeve on account of the thinness of the metal.

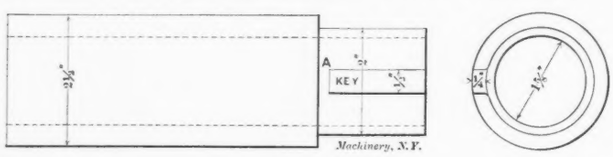


Fig. 1.

Another scheme, which may be of interest, is the method of chasing a groove of 1½″ pitch on some cast-iron wheels. The groove started at zero depth and increased to 1½″ in one revolution and then decreased to zero depth in the second revolution. The job was not required to be very accurate as the wheels were to be used for a wire rope, so we rigged up the arrangement shown in Fig. 3.

A wheel was chucked in the lathe and a 2¼″ flat bar F put between the centers, passing through the hole in the drum which was somewhat larger in diameter. A 48-tooth change gear which had a 2¼″ hole (hence the 2¼″ bar) was keyed to the flat bar. The bar was driven by a dog engaged with a spoke of the wheel. A plate A was bolted to the lathe bed and to it was bolted the block B carrying the stud C. A 96-tooth change gear was keyed to a sleeve that turned freely on this stud, as was also a crank disc having a crank-pin of 2″ throw. A connecting-rod from the crank-pin was attached to the lever D which was pivoted at E. The piece to which the lever was fulcrumed was bolted to the lathe carriage as shown. The lever was connected

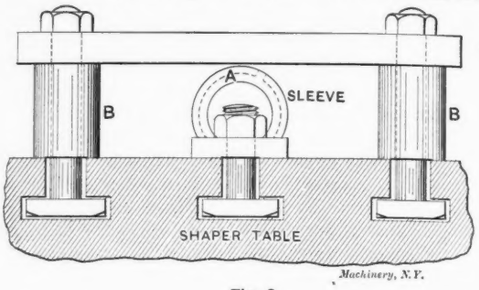


Fig. 2.

to the cross-feed screw by a fork and pin passing through an elongated hole to allow for the angularity of movement. The cross-feed screw was, of course, disconnected from the carriage so that it could be pushed in or out without interference.

When ready to chase the groove, the lathe spindle was revolved until the crank was in the position shown and then the lead screw nut was engaged so that the connecting-rod stood at about right angles with the ways when the tool was in the center of the face of the wheel, and the tool was fed into the work by

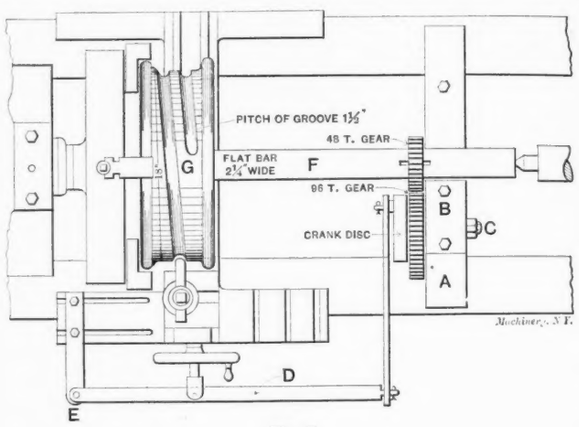


Fig. 3.

the compound rest. The holes in the connecting-rod were made so that it could vibrate sideways for the required distance without cramping on the pins. After the rig was ready we chased the grooves in the wheels in one and one-half hour and the time required to rig up was about twelve and one-half hours. The material used was scrap with the exception of the change gears, which were not changed. A. MERTES.

Emsworth, Pa.

* * *

REGARDING SHAPER SLIDES AND OILING CONVENIENCES.

Editor MACHINERY:

Referring to the May issue of MACHINERY, would say that there were two articles published in it on subjects which, it seems to the writer, ought to be further probed into, for the benefit of our craft. The first is the timely article by C. C. S. on "The Adjustment of Shaper Slides, etc." The fact is only too true that the temptation to handle the screw-driver on gib screws is too commonly resorted to among our fellow-craftsmen, when they ought, instead, to make haste to the grindstone and put their tools in proper shape and also see that all the slides and the ram are properly gibbed, clean and well lubricated.

All mechanics should know how to use these various tools, yet when such a construction is employed, how heedlessly the screw driver and oil-can are often handled. Still it is a simple thing to adjust a gib properly. An experienced erecting man gave the writer "a secret of the trade regarding gibs," which I will give here.

Slides, rams or cross-slides come under the same head. After

the guide opposite the gib is "lined up," adjust the other guide or gib so that the slide ram or cross-head will move throughout the entire stroke with the same degree of smoothness without the aid of any lubricant, unless in very large work, where a judicious amount of dry plumbago would be of service. It is plain that a piece of work fitted up in this manner, would prove worthy of the builder, when lubricated with clean oil, and if it were properly cared for, cuts and scratches would be a thing unknown.

The other letter referred to is that of Mr. A. Mertes on "Oil Holes in Machinery." The trouble he speaks of is encountered every day, and, of course, the oil holes and grooves are at fault (?). This clears us of all responsibility. The oil holes and grooves being found faulty, we proceed to remedy this by making the way clear to care for a larger amount of oil and pass the same through the extended grooves and thence into the sewer trap, providing the shop in question happens to be without an oil filter.

The reader must excuse my exasperation, but the alteration and destruction of machines which the manufacturer and designer have built in a certain way for a purpose are above all things the most trying. If we have a large bearing with properly cut oil grooves and provided in its pipe with the usual oil wick, why should a mechanic expect good results from heavy oil under conditions of cold weather. If compelled to use this under the named conditions, good sense should tell him that a dose of kerosene is needed as often as oil. This applies to the trouble of Mr. Mertes. Keep the oil pipe, grooves and journal free from dirt and lubricate with a moderate amount of clean oil and you need never fear a hot or dry journal. Still other evils exist in the machine shop. The back gears of lathes are often misused as it is the prevailing custom not to fully mesh them together, presumably to have them run more quietly. When such gears get a touch of asthma—caused by an excessive amount of grease and gum—the remedy which has already been mentioned is resorted to and for a time appears successful, but conditions remaining the same, there is sure to be a repetition of the trouble.

Washington, D. C. F. T. MILLER.

* * *

GEOMETRICAL METHOD FOR ORIGINATING AN INDEX PLATE.

Editor MACHINERY:

To originate a correct index plate is a difficult undertaking and one that has been the occasion of much thought and experiment. While it is apparently a simple matter to divide a circle into a certain number of divisions, the actual difficulties met by any method by which corrections are obtained by repeated trials are enormous when perfect accuracy is required. That which would

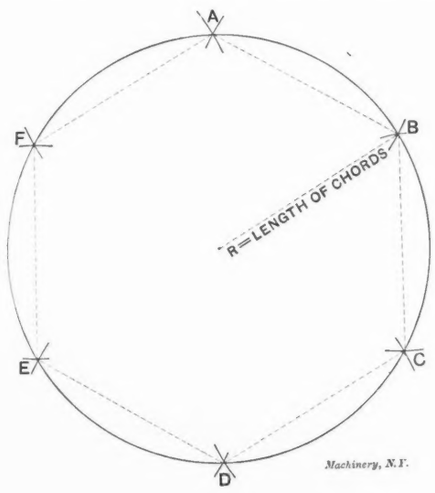


Fig. 1.

be eminently desirable for such a process would be a geometrical method by which the divisions would be obtained without the necessity of corrections for original errors in spacing. In thinking somewhat on the subject, the writer has developed the herewith described geometrical method for forming index plates of six holes, which, although of little practical value, may serve as a hint by which the formation of plates having a greater number of divisions may be formed by analogous processes.

The process of dividing a circle into six equal parts as shown in Fig. 1 is familiar to all draftsmen and most machinists and is known to be perfectly accurate, since it is geometrically correct, as is proved in any text-book on geometry. Now, if we can duplicate this action mechanically, the result will be a correct spacing for six holes.

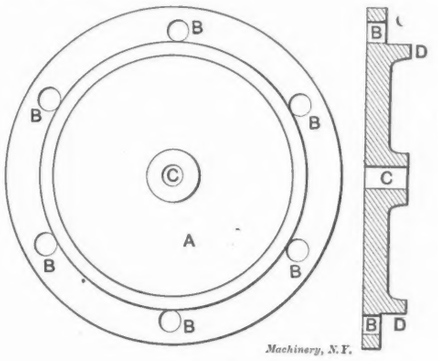


Fig. 2.

To effect this the method illustrated in Figs. 2 and 3 can be used. To form an index plate on a common lathe, it will be necessary to have the swing something over twice the diameter of the circle on which the holes are located. The plate A, Fig. 2, is first turned all over. It has a flange D which should be something less in diameter than the circle touching the inner edges of the holes to be made, and when the flange is turned, the hole C should be bored at the same time and of the same diameter as desired for the index holes. A center is fitted to the lathe arbor and turned on its outer end to a diameter that will depend on the clearance allowed between the flange D and the inner edges of the index holes—say twice 1/16" or ⅛".

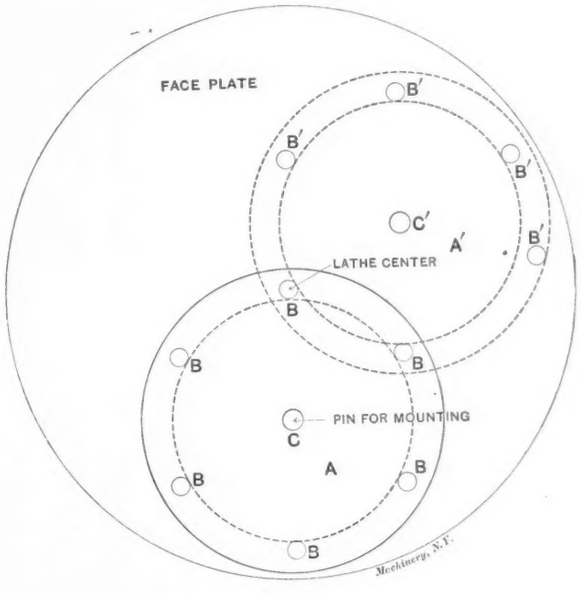


Fig. 3.

A pin C Fig. 3 is also turned to the same diameter as the hole in the center of A and is provided at one end with a shoulder and clamping nut so that it can be engaged in one of the face-plate slots. The index plate is now mounted on this pin and located so that the periphery of the flange D will be against the lathe center which was turned as described. The pin is secured in the face-plate slot and the index plate securely clamped to the face-plate. A hole is then drilled and bored in the index plate to the same diameter as the hole in its center. After the hole is finished, the plate is removed and mounted on the pin C by passing it through the hole just bored. The plate is then swung until the flange D strikes the lathe center and is then clamped fast as shown in Fig. 3. Another hole is drilled and bored to the standard size and then the plate is loosened and swung in the opposite direction until the flange D again strikes the center plug as shown at A′. The operation is repeated as before and

the process is continued by "stepping" around until all the six holes are drilled and bored.

It will be observed that the measurements are entirely automatic, the only thing requiring extreme accuracy on the part of the operator being to bore the holes of uniform diameter, which is an operation easily performed. As intimated at the beginning such a process will usually be of little value, as a six-hole index plate is rarely used, but it may be that the principle with modification can be extended to embrace higher numbers.

Newark, N. J. F. EMERSON.

* * *

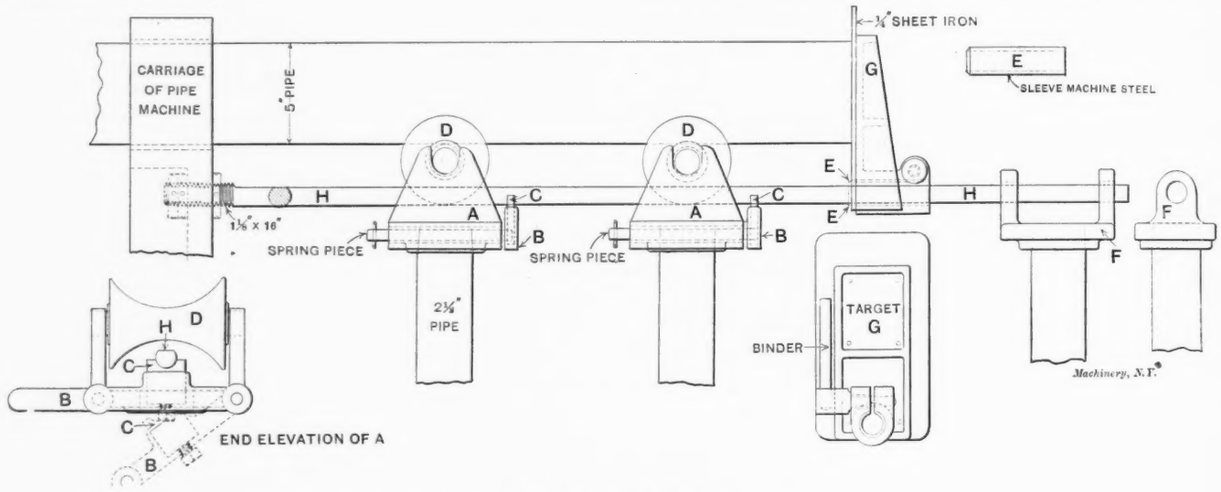
PROFESSIONAL CONSULTATION VS. MECHANICAL ADVICE.

Editor MACHINERY:

I would like to ask the contributors of MACHINERY why a mechanic should not be paid for his advice the same as a professional man. I put the same question last summer to a gentleman who stands high as a mechanic, writer and lecturer, and he answered, "I have a case in point. My doctor has often insisted that I should be paid for advice. Now the said doctor was going to put a furnace in his house and he asked me to decide for him which one was the best. I spent six hours looking over the different circulars and gave him my opinion, whereupon he simply thanked me for it."

Now, that gentleman's time was worth as much as that of any doctor or lawyer in the United States, yet because he was a mechanic, he got nothing for his time but thanks, which, in my opinion, is all wrong. J. W. H.

Springfield, Vt.



Attachment for Pipe Machine.

TARGET AND SCALE FOR PIPE MACHINE.

Editor MACHINERY:

The accompanying cut shows a target and graduated scale for a pipe machine, which together with the following description will illustrate a device or shop kink that has increased the output 30% in its own specialty, namely, cutting off pipe. This increase has been acknowledged by the company and verified by the foreman of the department where it is used. The acknowledgment of the company was shown by the equipment of two other machines with the same arrangement soon after the first.

Referring to the cut, H is a 1⅛" cold rolled shaft 14 feet long milled on one side to ⅞" flat as shown in the elevation A, and graduated to eighths the whole length, except where it passes through the carriage. It is secured to the carriage by lock nuts. G is the target made of cast-iron and faced with ¼" sheet iron. It is bored ¼" larger than shaft to receive the steel sleeve E which has a beveled edge projecting from the face of the target. The sleeve is clamped securely in place by a split boss and binder, as shown, and is kept in position laterally by a small pin in the lower side of the boss. The beveled edge of the sleeve makes it possible to adjust the target very accurately to the graduations on the shaft.

F is an end support for the shaft and is made of cast-iron. D D are cast-iron pipe rolls cast solid. Although shown in the cut with the pipe resting in the bottom of the rolls, they are not intended to take the weight of the pipe when cutting it off, as the pipe machines are provided with powerful chucks, one on each end of the spindle, besides V-guide jaws close to the cutting off tools. These rolls simply catch the pipe when it is cut off, thereby preventing it from falling on the scale and bending it. That these rolls do not support the pipe is further shown by the fact that this machine cuts pipe down to 2", and the rolls have no vertical adjustment. When the pipe is cut off, a laborer stands close to the machine ready to carry it away to the pile. The rolls relieve the man of the sudden weight when large pipe is being cut off, and are removable as shown in the sketch, so as to allow target to pass through. When target is between the carriage and the first roll which is 3 feet away from carriage the man must catch the pipe. This is not so difficult on short pieces, as the speed of machine is slow. It will be seen that a center support was necessary for the shaft H, as it is about 13 feet between bearings, and the rear one is a sliding fit.

The middle supports were arranged as shown in the end elevation of A. B is a cast-iron lever swinging from center O on the back end of the bracket A. It is held in the horizontal position, shown in full lines, in elevation of A, by a spring pin. C is a piece of hard wood 2½" x ½" fitted into a cored socket cast in the lever B, and is adjusted to the shaft by the set screw shown. The swinging down of the lever B with center support C from H allows the target to pass through the roll bracket, and as these brackets are 4 feet apart the shaft can always be supported at one of these points. A A and F are screwed on the end of a piece of 2½" pipe and are flanged to the floor. The whole thing works very smoothly as compared with the old way, which employed a piece of ½" pipe screwed into the carriage at the same point where H is secured. On the ½" pipe was fitted a target with such a fit as was possible to make on ½" rough pipe; the target was held by a set screw. The pipe very soon became indented the whole length by reason of the set screw and had to be frequently replaced with a new piece of pipe. The target was set with a 6-foot sliding rule, making about 11 feet 6 inches when extended. These rules were of wood and must often be replaced by reason of the figures wearing off and they were by no means as accurate as the steel bar, besides having to be set every time a change was made. By having one continuous rule and that of steel all that is necessary is to slide the target to the required position and bind it. The carriage as shown is in the nearest position to face of chuck. End bracket F must be set so that the shaft will always have a support in it when it is in its most forward position, as shown. The carriage has transverse travel of about 16 inches.

This is not as expensive a rig as it might seem, the shaft being bought finished and costing about $1 per foot for graduating. I think it would be hard to beat, for it stands the racket which is considerable. It was after considerable thought that it was decided to make the scale of 1⅛" round shaft, the only other good reliable thing to do being to butt three of Brown & Sharpe's 4-foot scales together and having then only 12 feet and at a cost of about $2 per foot at the least. Then came the problem of holding the scales and sliding the target thereon,

without using a separate slide for the target and a delicate pointer from the target to the scale, continually liable to be bent or broken. With our round scale, however, everything is central with the spindle of machine. It seems to me that this would be a good extra attachment for some builder of pipe machines to add to his standard machine, for it has filled a long felt want in our shop. W. J. H.

Providence, R. I.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

The following quoted from the U. S. Ordnance Report for 1898 with regard to blueing gun barrels was sent in by Mr. E. S. Parmenter, president of the United States Rifle Implement Co., Bennington, Vt., in answer to question 54 in the May issue.

Boil the parts in caustic soda to remove the grease. For blueing, a cast-iron tank open to the air is employed. The blueing mixture (100 pounds of nitre and 8 to 10 pounds of black oxide of manganese) is raised to a temperature high enough to cause a quick ignition of a pinch of sawdust thrown upon the surface. The cleaned parts are suspended in the center of the mixture in wire baskets suspended from stationary hooks above the pot. They are immersed when cold and are moved about to keep the mixture stirred up. Immerse from five minutes up, depending upon size of parts and shade of color desired. Remove parts from time to time to observe the effects of the treatment in regard to color, etc. After a satisfactory color has been obtained, the parts are plunged into cold water to prevent spotting; next into a vessel of hot water to remove the nitre; then into a vessel of sperm oil to darken and fix the color, and finally into benzine to remove the oil. Wipe dry and the process is complete. The temperature of the blueing mixture should be about 400° Fahrenheit and should be kept well stirred.

We have also received the following from J. C. Dunn, Montreal, Can.:

In question 54 of the May issue you ask for a cement to fasten leather to cast-iron. It gives me pleasure to send you the following, which I have used with success, and if the job is properly done no rivets will be required. The following ingredients are required: 1 pound best flour, ¼ pound best glue, ½ pound granulated sugar, ½ ounce powdered borax, ½ ounce sal-ammoniac, ¼ ounce alum. Soak the glue in three pints of soft water for 12 hours, or if you have glue already melted pour in the quantity. Mix the flour in one quart of soft water, mix all altogether, and boil over a slow fire, or cook with a steam jet. When cool it is ready for use. The face of the pulley or surface where the leather is to be applied must be thoroughly clean and free from grease.

62.—"Fountain Pen": Having occasion to solder some pieces of cast-iron I find the ordinary process very unsatisfactory. Please tell me the "secret."

A.—We submit this to our readers.

63.—I. T. N.: In worm gearing, is the pitch of a double-thread worm the same as the lead? In other words, since, with a double-thread worm two teeth take the place of one large one, does the pitch include two teeth and two spaces?

A.—Yes. See answer to question 57 in the May number.

64.—E. C. H.: Will you kindly tell me which you consider the stronger, a bicycle frame with head measuring 11½ inches long or with one measuring 5½ inches, the size of the tubing being the same.

A.—A low frame resists sideways deflection and twisting better than a high frame, because, first, the forces act with shorter leverages, and, second, the rear tubing, from each end of the rear hub, is inclined sideways slightly more in the low frame and makes a stiffer brace. Disregarding the side strains, the high frame will undoubtedly support a weight in the saddle with less deflection than will a low one. For practical use, we consider the low frame the stronger and stiffer, provided the head is long enough to give a solid support for the forks.

65.—J. E. O.: Please tell me the difference between emery, corundum and carborundum.

An article by Warren E. Willis was published on this subject in the September, 1899, number of MACHINERY, from which we quote: Emery is obtained principally from the islands of the Grecian archipelago; its hardness depends upon the amount of iron and silica in its composition. It is of the same mineral species as many of the Oriental precious stones, such as rubies and sapphire, but of a dense, opaque, dull bluish or brownish black color. Corundum is a mineral—alumina—remarkably hard, a species of gem stone, of which emery is a variety; it is used as an abrasive in polishing and grinding. Carborundum is an artificial product of the electric furnace acting upon clay; the grains produced are next in hardness to the diamond, being superior to emery. It is used in the same manner as emery.

66.—M. B. C.: Will you kindly inform me how to calculate the different change gears for any number of threads per inch by combinations of the nest of gears shown in the accompanying sketch of a 60" lathe. The gears D, E, F, G, H and I are never changed, the change gears being J and K. Is there any way that these gears could be compounded to cut a certain thread that could not be cut direct?

A.—The method followed in calculating the number of threads that will be cut with any combination of gears on a lathe as shown does not materially differ from that employed on those having simple gearing, and, in fact, is exactly the same when the pin is engaged with the middle gear of the nest of three gears F, E and D because the velocity ratio from lathe spindle to gear I is then unchanged. Suppose that the pin is engaged with the middle gear E, what will the thread cut be when K has 40 teeth? Since gear B on the lathe spindle has 33 teeth and gear C also has 33 teeth, the sleeve carrying the pin must always rotate at the same rate as the lathe spindle. Now, as the pin is supposed to be engaged in the middle gear E which has 36 teeth, it is evident that the three gears G, H and I will rotate at

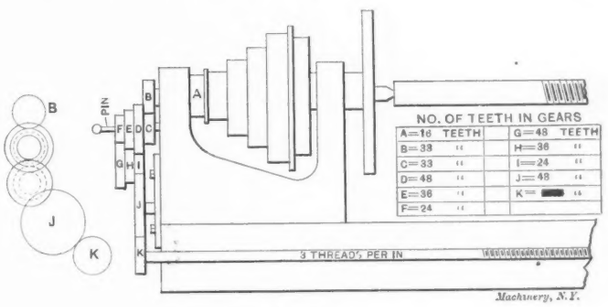


Fig. 1.

the same rate as E since H, the driven gear, also has 36 teeth. It then follows that the gear I rotates at the same rate as the lathe spindle when the pin is in the middle position, so all that need be considered, is the relative ratios of I and K. Since K has 40 teeth, the thread cut will be 40 × 3 (number of threads per inch in lead screw) divided by 24 (number of teeth in gear I) or 5 threads per inch. Thus when the pin is engaged with the middle gear the calculation will be exactly the same as for a simple lathe. When the pin is in either of the other two positions, multiply or divide the result found when considering the middle gear as the driver, by the ratio existing between F and G and between D and I. Since G has 48 teeth and F has 24 teeth, the ratio between them is as 2 is to 1. So with K a 40 tooth gear, the thread cut would have twice as many turns per inch as with the middle gear engaged, with F engaged by the pin, or 10. With the pin engaged with D, the ratio would then be as 1 is to 2, therefore, the number of turns per inch of the thread generated would only be one-half as many as on the middle gear, or 2½ turns per inch. You will thus see that if you can cut a certain thread with the middle gear engaged, you can also cut twice as many threads per inch, or one-half as many by shifting the pin. Otherwise such a scheme of lathe gearing offers no advantages over the simple form.

67.—G. G. A.: Can you tell me whether there is a combined steam and gasolene engine and give me the name of the company who manufacture it?

A.—It is possible that some of our readers can answer this question for you. The only engine of this character that we

know of is described in one of the early editions of Clerk's "Gas Engine." He describes a Brayton petroleum engine in which the heat from the cylinder walls and the exhaust gases was made to generate steam. This steam was turned into the motor cylinder along with the flame and it was found that the cooling effect of the steam practically balanced any gain that was realized from the increase in volume due to the steam. Clerk estimates that if a separate steam cylinder had been used, about 6% gain in economy might have been realized. Such an apparatus, however, would necessarily be complicated and of doubtful utility. The firm trying the experiment was Messrs. Simon, Nottingham, England.

68.—H. W. L.: 1. I recently had an argument with some of the men in the shop over lathe centers. They claim that a 60° center is less acute than a 45° center, also that the angularity of a lathe center is measured by the difference in direction of the lines BC and BA in the sketch. Since in this case the angle ABC is 45°, they claim that the center is properly called a 45° center. 2. At what angle must a lathe tool be set to turn a cone of 30°?

A.—The angle of a lathe center is measured at the apex A and includes the angle BAC instead of being measured at the side, as your friends believe. In the sketch a 90° center is shown by the full lines and a 60° center by the dotted lines. In the latter case the angle is BA'C. You will notice that the angle included between the lines BA and BC is only 45° for a 90° cen-

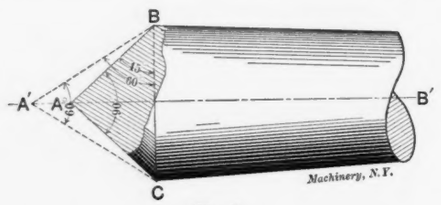


Fig. 2.

ter, while it is 60° for a 60° center, but, as stated, the angle denoting the shape of the center is always measured at the apex. 2. The answer to this question depends on what the angular measurement is to be taken from. If the angle is to be measured by the angular difference between the line joining the lathe centers and the path of the cutting edge of the tool, it would have to be set at 15° in order to turn a 30° cone.

69.—T. H. R.: Will a spur gear of 156 teeth, 12 pitch, roll within an annular gear of 180 teeth?

A.—An external gear of 156 teeth, 12 diametral pitch, involute system, will roll within an internal gear of 180 teeth. A spur gear will roll within an internally toothed gear when the latter exceeds it by at least 12 teeth, when this number marks the gear of the interchangeable series having radial flanks. Gears cut by the Brown & Sharpe system will, however, run together only when the difference in number of teeth of the two gears is at least 15. While an involute tooth for an internal or annular gear should have concave surfaces, they are cut in practice with a No. 1 Brown & Sharpe cutter of the desired pitch, the slight inaccuracy not affecting the practical result. In fact, it makes little difference whether the spur gear flank engages with the annular gear tooth face or not, as it is sufficient to have flank contact in the latter only.

70.—C. F. B.: Kindly inform me of the composition of type metal and also of the metal used in the Linotype type-setting machine.

A.—Kent's pocketbook states that type metal is made of lead and antimony, the proportion of the latter being from 17 to 20 per cent. Each type foundry has a composition of its own, which is supposed to be kept secret. Some claim to put in a little copper and others nickel; but the bulk of the metal consists of lead, tin and antimony in varying proportions. Linotype metal is made from lead, tin and antimony in the proportion of 700 pounds of lead, 50 pounds of pig tin and 100 pounds of antimony. This is the formula recommended by the Mergenthaler Linotype Co. They also state that if a hard type face is desired, 5 pounds of antimony and 2½ pounds of tin should be added to the above mixture.

* * *

A leather belt 6" wide, traveling at a velocity of 2,000 feet per minute should easily transmit 12 H. P.

NEW TOOLS OF THE MONTH.

Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.

MULTI-SPEED EMERY GRINDER.

In the accompanying illustration is an interesting application of the electric motor to independent driving. It shows the Stow multi-speed motor, of which we have previously published a description, adapted to an emery grinder. The machine is designed for two 14-inch wheels and the motor will drive the wheels at any speed from 960 to 1600 revolutions. Starting at the proper speed for these wheels, as they wear away the speed can be increased so that a peripheral speed can be constantly maintained, allowing the emery wheels to always cut to the best advantage.

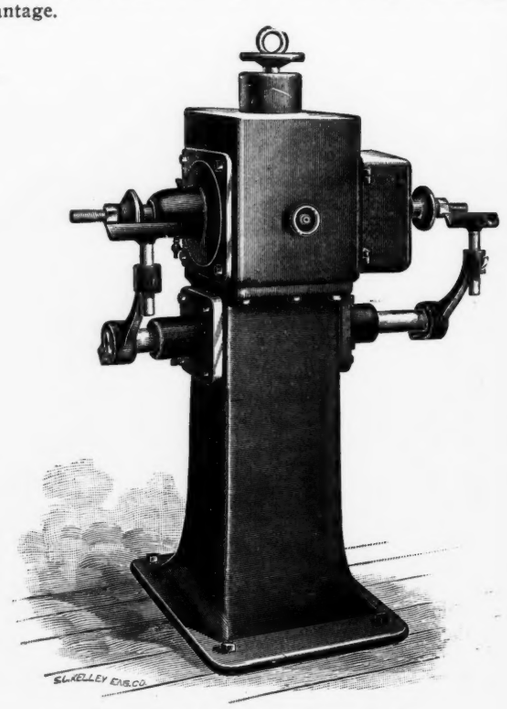


Fig. 1. Electrically Driven Emery Grinder.

It will be noted that the motor is enclosed and dust proof and that the wheels are mounted directly on the armature shaft. This not only makes a simple and convenient arrangement, but the design of the motor is such that the danger from the wheel bursting, due to too high speed, is largely eliminated, because the speed regulating device can be placed entirely within control of the foreman. The speed is varied by moving a core in or out of the hollow pole piece of the motor, which varies the magnetism of the pole piece and so varies the speed of the motor. This core is seen projecting from the top of the motor in the engraving, and it is arranged so that it can be locked and the speed cannot be changed by any one unless he has the key. This machine is manufactured by the Stow Mfg. Co., Binghamton, N. Y., and is one of several applications of this type of motor that they are now manufacturing.

NEW COINING MACHINERY.

The two machines shown in the engravings on the next page have been made from the designs of Mr. Oberlin Smith, by the Ferracute Machine Company, of Bridgeton, New Jersey. They have been sent to the Paris Exposition, where this company have three separate exhibits.

The machine shown in Fig. 2 is known as a coin-miller. Its function is to take flat "blanks" (discs) of metal, which have previously been punched from the sheet, and mill their edges. This operation consists of thickening up and rounding the edges and is performed by hand-feeding the blanks into one of the slotted tubes shown rising from the table, from the bottom of which they are carried, by the action of feeder-arms, between the externally grooved steel disc, and the segment of an internally grooved steel ring. This segment, known as a jaw, is set some-

what eccentric to the disc, so that the ever-lessening distance, as the blank is rolled between the two, will reduce its diameter to the proper amount. After leaving the jaw it drops through a hole in the table, falling into the box shown beneath.

The automatic feeding of the bottom blank of the pile in the tube is accomplished very simply by a thin rotating arm mounted upon the top of a small vertical shaft, this shaft being driven by a friction-gear inside the table, which is recessed for the purpose. This friction gear is simply a cylindrical disc resting by spring pressure against a similar larger gear mounted upon the main shaft. It can be instantly thrown out of gear by the small handle and latch shown projecting through a slot in front of the table.

It will be noticed that there are three different tubes, of different sizes, arranged each one-third of the way around the table. In the older form of machines the table was stationary,

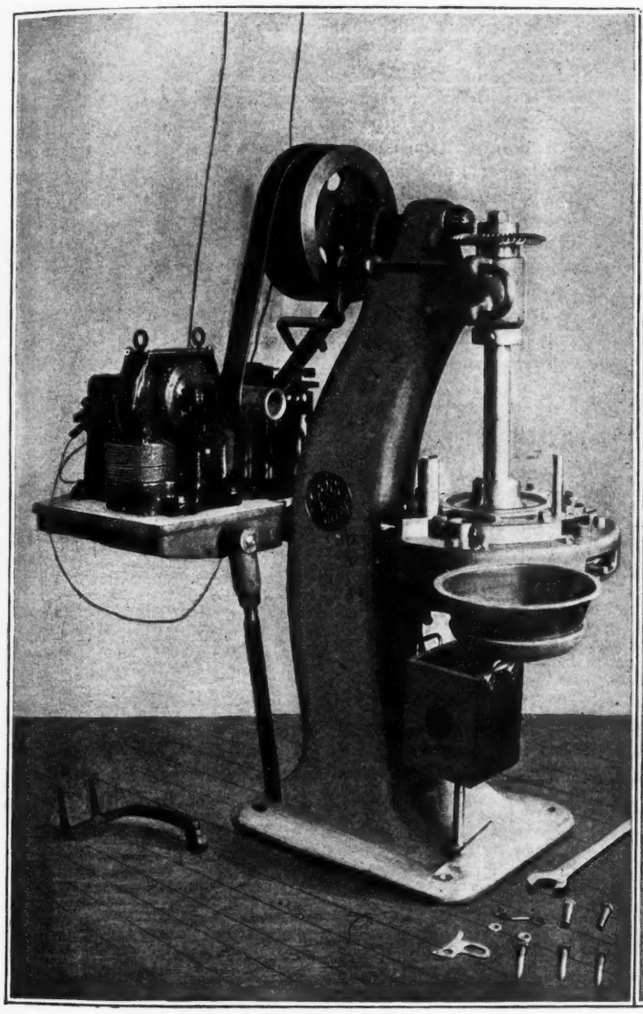


Fig. 2. Coin Miller.

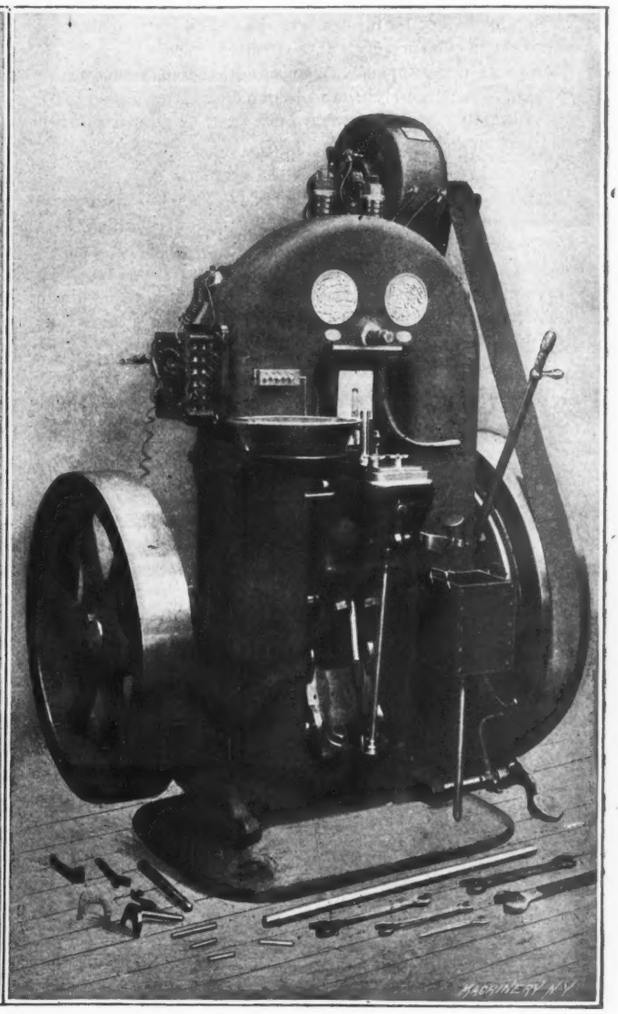


Fig. 3. Coining Press.

the operator going to the tube at which he wished to work. In the present machine the table is made to revolve about its own axis, being quickly latched by a small spring bolt in any one of three positions. Thus three sizes of tubes, feeders, jaws, etc., can be kept mounted for three given sizes of coins or medals, the change from one to the other being almost instantaneous. The speed with which these articles can be run through the machine varies from 200 to 400 per minute.

The machine as shown is equipped with an individual electric motor, mounted upon a shelf having an adjustment for taking up the length of belt. Sometimes, however, it is run direct from line shafting, in which case another form of shipper may be used to advantage.

The milled blanks are known as "planchets," and after leaving the coin-miller are ready to be fed into the coining-press, to be made into coins or medals, as the case may be. The object of milling is two-fold. First, that the sharp corners of the blank may be sufficiently rounded so that the pressure of coining will not quite bring them up to a sharp edge again, as with the ordinary type of coining dies working in a cylindrical collar it is impossible to form smoothly rounded corners. The tendency of the metal under pressure is to flow wherever it can, sometimes going so far as to flow up between the cylindrical part of a coining die and its surrounding collar, so as actually to form thin sharp fins. The second object of milling is to make the edges of the planchet thicker, leaving the main face as a sunken panel, thus giving metal to make the rim which usually forms part of the design of the coin, and which serves to protect the central ornamental parts from abrasion, in cases of sliding over flat surfaces, etc.

The machine shown in Fig. 3 is an automatic toggle-coining press, of the type usually built by the Ferracute Machine Company, with a number of improvements which simplify the feeding and ejecting operations. The ultimate capacity of this machine, in the way of ram pressure, is 250 tons, but for ordinary work, making continuous strokes, it is usually run at a considerably less pressure. It is, however, amply large for coins or medals up to the size of a half-dollar.

By the newly designed arrangement in question, the automatic motions are all obtained from the motion of the ram itself, by means of the rods shown in front of the machine. The device forming the automatic feeder can be removed in a few minutes, thus rendering the press suitable for ordinary hand feeding.

Among other features of this design are the placing of the toggles under the bottom of the ram, instead of in the usual position at the top, thus pushing it upward and forcing the lower die against the coin, the upper die being stationary. One obvious advantage of this arrangement is that no oil or grease can get upon the coins, as all the moving parts requiring lubrication are below the point of operation. Another is the absence of

"lost motion," as the plunger and the different parts of the toggles are held close together by gravity, while in the case of the upper toggles generally used, gravity tends to pull everything apart, and cause a lost motion which is calculated to damage the dies, and to make a rattling noise when running.

Another unique feature is the fastening of the upper die to an oscillating head, which can, in a fraction of a second, be swung forward and upward by means of the two handles shown in front of the machine, one of which unlocks this head and the other of which raises it. This allows an unusual convenience of access for inspection and cleaning of the dies, an access which is generally obtained by an unnecessary long die stroke of perhaps a couple of inches. In this case the stroke of the die approximates ½", which short stroke not only allows the coin to be confined so that it cannot jump out of place, but causes much less wear upon the machine than usual, with consequent durability. It also insures a minimum of noise, and enables the press to be run considerably faster than is customary. The feeding devices are also arranged with a very short stroke.

This press is equipped with a friction clutch, operated by the handle shown at the right, and is driven with an individual electric motor, duly provided with a rheostat, as shown respectively at the top of the machine.

EXPANDING MANDREL.

The Western Mfg. Co., Springfield, Ohio, have brought out a neat expanding mandrel called the "Champion," which is shown in the accompanying illustration. It consists of two parts, one of which is a sleeve, tapered inside and split longitudinally in several places, as indicated in the illustration, and the other of which is a taper arbor to be driven into the sleeve, thus expanding it. It will be observed that the arrangement of the slots

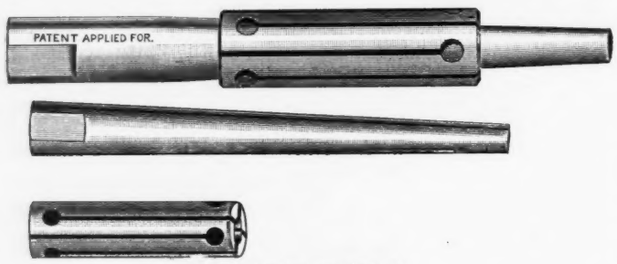


Fig 4. Expanding Mandrel.

in the sleeve is such that it is very flexible and will conform closely to the cylindrical form, even when expanded to quite an extent. Both parts are of tool steel, hardened and ground. The sleeve, being shorter than the arbor upon which it fits, allows overhanging when facing, thus obviating the liability of cutting into the mandrel. The taper is such that the mandrel is easily released and yet it will hold the work securely.

CONSOLIDATED SPEED CONTROLLER.

The principle on which the device operates will be understood by referring to the sectional cut Fig. 5. Two opposing discs A B are mounted on the shaft, one being secured to the shaft S and the other to the sleeve Q. The discs A B are of such shape that when in the position shown, the space between them on each side of the shaft is of circular section. Between the discs are mounted suitable rollers C C which transmit motion from one disc to the other. Thus if the power is being transmitted through the pulley G and the shaft S, the disc B will be the driver and the disc A will be driven in the opposite direction and at a speed ratio that will depend on the angular position of the friction rollers C C. If they be in the position indicated by the full lines, it is evident that A will have a slower angular velocity than B, since the motion of B is transmitted from a surface having less than one-half the radial distance from the center of rotation as that of A to which motion is transmitted. On the other hand, if the friction rollers are in the position indicated by the dotted lines marked C' C', the angular velocity of A will be greater than that of B, as the conditions are reversed. If the rollers C C be shifted so that their sides stand parallel to the shaft, the angular velocity of both discs will be the same, as motion will be transmitted between equi-distant surfaces.

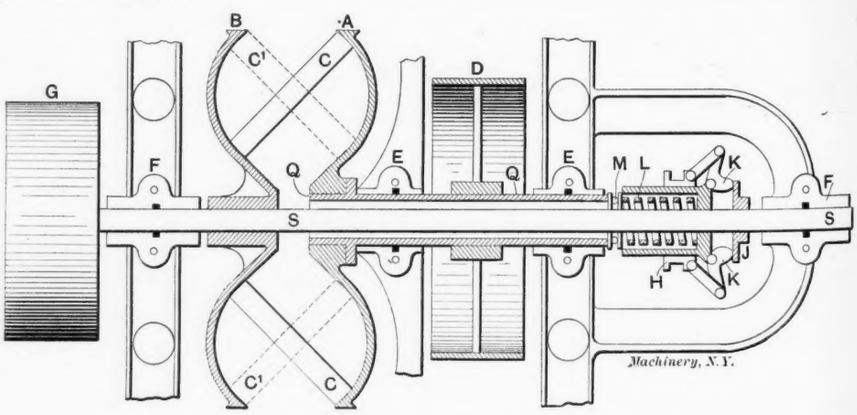


Fig. 5. New Variable Speed Device.

The end thrust caused by the pressure necessary on the friction rollers is taken on a ball bearing at M, and the pressure is maintained through the medium of a coil spring L. To throw the device into action, the clutch collar H is moved to the left, which action operates the levers K K and produces a powerful end pressure between the sleeve carrying the coil-spring and the collar J, which is solidly attached to the shaft S.

To vary the speed, a lever not shown is used by which the rollers can be turned from the position indicated by C C to that indicated by C' C', thus giving any desired ratio between 7 and 1. Thus if the pulley G were driven at 210 turns per minute, the rotations of D could be varied from 80 to about 560. In some sizes, however, the ratio of change varies between the limits of 1 and 10.

The wide field for variable speed devices is well known and needs no specific mention here, but one use can be specified in which the great gain is well worth noting, and that is in transmitting power to high speed machinery. It is well known that to get many machines, like extractors, to running at top speed is an operation requiring some caution on the part of the operator to avoid breaking or running off of the belts. In any event the time taken is considerable, as the slipping of the belts is so great that the acceleration is slow. With a variable speed device, however, the starting of high speed machinery is a simple matter, and can be effected in a fraction of the time ordinarily required, as there need be no slipping if the operator properly manipulates the controller.

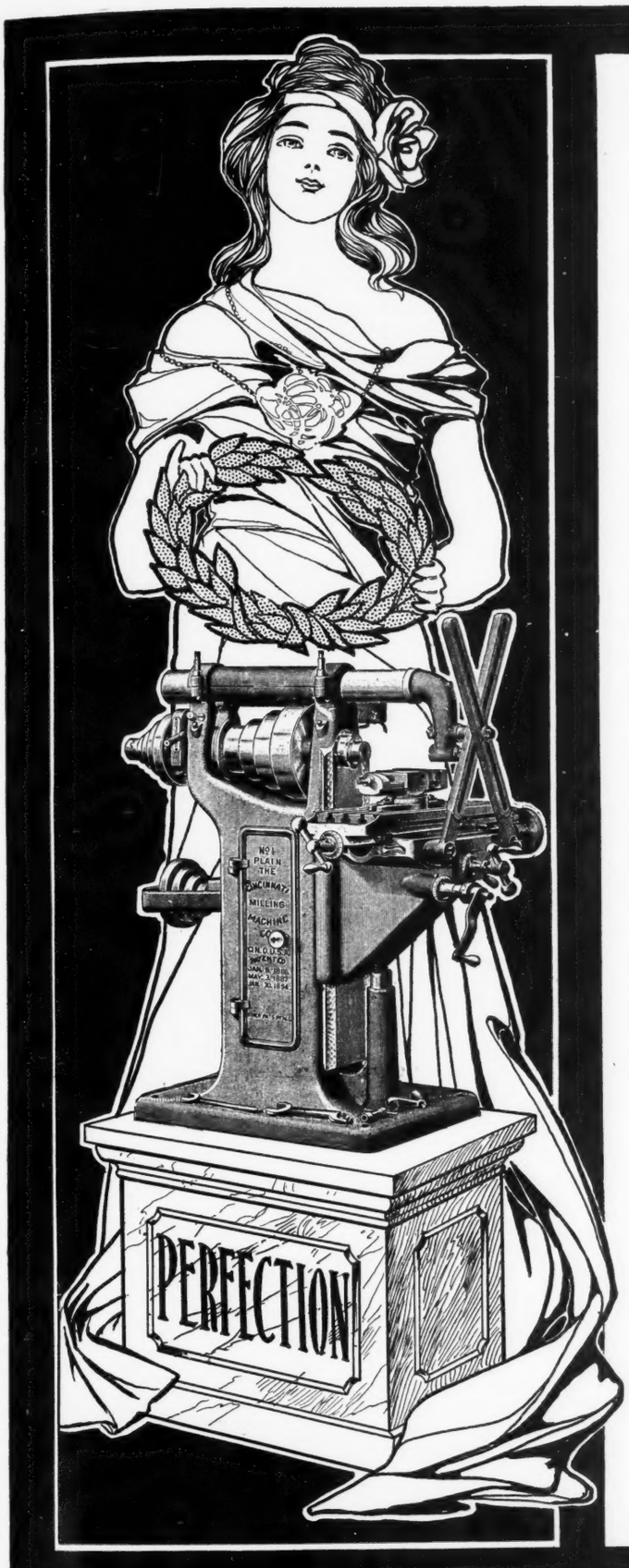
The Consolidated speed controller is made by the Consolidated Machine Specialty Co., 185 Franklin Street, Boston, Mass.

WARM WEATHER FANS.

The electric disc fan has become established as a local cooling device for summer use, but its ability is limited to merely stirring up a breeze. For the actual movement of air to or from buildings or through ducts a different type is required. The B. F. Sturtevant Co., of Boston, Mass., are now building a type of electric propeller ventilating fan such as is shown in Fig. 6, on the next page, which meets the latter requirements.

The fan wheel is carefully designed to act against reasonable resistance and to move the air in lines parallel to the axis of the shaft. It is contained within a special circular frame casing which is conoidal in its form as it approaches the circumference of the wheel. This results in decreasing the resistance offered to the entering air. The frame carries a tripod support with annular center within which is accurately placed and centered a bi-polar motor, consisting of a circular field ring to which the pole pieces are attached. Extending out from either side of the field ring is a yoke which contains the ring oiler bearings. The bearings are self-aligning and self-oiling, and fitted with composition sleeves which are removable from the outer end of the boxes.

Hard carbon brushes carried in holders of a modified reaction type are employed and permit of easy adjustment when



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it becomes necessary to reverse the direction of rotation of the motor. Special light end casings with removable centers are provided, which when applied and bolted in place entirely enclose the motor, thereby absolutely protecting it from dust. This is a most important feature in a machine of this type where the air possibly laden with dust is drawn directly across it. The movement of this air is of great service in maintaining a low temperature of the surface, while the motor itself is designed to

Fig. 6.

avoid excessive heat. This motor is capable of continuous operation for 10 hours with a maximum temperature rise which does not exceed 60 deg. F. The entire apparatus is ordinarily shipped complete and may be bolted directly to an opening in the wall through which the air is drawn or forced. These are built in sizes from 18″ to 120″ in diameter with capacities ranging from 2,000 to 175,000 cubic feet per minute and driven by motors ranging from 1-6 horse-power to 14 horse-power.

THE STANDARD ADJUSTABLE CHUCKING REAMER.

This tool is intended to meet the requirements of general machinists and electrical repairers. The main body of the tool is one solid piece of steel and the original centers on which the reamer is ground are retained.

The blades are of tool steel, carefully hardened. It will be noted that the back ends of the blades are beveled and clamped

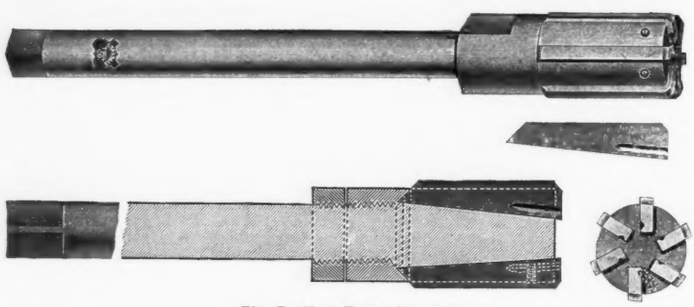

Fig. 7. New Expanding Reamer.

securely to the body of the reamer by a lock nut, while the front ends are notched to give a bearing for the points of set screws which clamp the front ends of the blades. There is a wide range of adjustment, 1-16th of an inch being allowed for wear and regrinding, and the reamer has but few parts. The blades are interchangeable and can be replaced when worn to their limit, thus obviating the cost of an entire new tool. It is made by the Standard Tool Co., Cleveland, Ohio.

* * *

FRESH FROM THE PRESS.

Practical Treatise on Gearing. Sixth edition. Published by Browne & Sharpe Mfg. Co., Providence, R. I. 158 pages and 71 cuts.

The sixth edition of the Treatise on Gearing is a revision of the matter that has previously appeared to which is added a chapter on cutting spiral gears in the universal milling machine.

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The rapidly extending use of spiral gears makes this chapter very appropriate. It is, perhaps, superfluous, but an assurance to many prospective readers to state that the treatise as a whole is adapted for the practical mechanic who has neither the time nor education to appreciate the rigorous mathematical treatment accorded this interesting subject by many books on gearing, but who can understand ordinary arithmetical calculations.

The Technic of Mechanical Drawing. By Charles W. Reinhardt, Chief Draftsman of the Engineering News. Published by the Engineering News Publishing Company, New York. Price $1.00.

The book contains eight chapters besides ten plates that are exceptional specimens of the draftsman's art. All the cuts shown are photographed from the originals and they are an incentive to the young and ambitious draftsman who desires to master the art of making fine drawings. The chapters take up in order: Outlining, Outline Shading, Section Lining, Curved Surface Shading, Shading of Inclined Surfaces, Map Drawing and Character and Finish. The work is better adapted to the needs of the young civil engineer or architect than for those connected with the machine shop.

ADVERTISING LITERATURE.

We have received from the Sterling Emery Wheel Mfg. Co., Tiffin, Ohio, a price list of their emery and corundum wheels. The pamphlet contains a table of safe speeds for emery wheels, and other information.

The New Process Raw Hide Co., Syracuse, N. Y. Catalogue of New Process raw hide gears; pocket size. A large number of gears of different dimensions are listed in this catalogue, as well as some other raw hide specialties, such as bushings and hammers.

A standard size catalogue of upright drills for both heavy and light work has been received from the Cincinnati Machine Tool Company, Weston avenue and Dayton street, Cincinnati, Ohio. This line of drills is new and is clearly described and illustrated in this catalogue.

The Prentice Bros. Co., Worcester, Mass., have issued a pocket size catalogue of their upright and radial drills and lathes. It contains illustrations and descriptions of the numerous styles and sizes in which their tools are made.

We have received from the J. H. Williams Co., manufacturers of drop forgings, Brooklyn, N. Y., a new catalogue in which a number of products are listed that have not previously been shown. Among these are a line of drop forge socket wrenches, a regular line of valve stems, rod ends and crank shafts, which are carried in stock, a line of straight tail dogs, a line of hoist hooks and automobile forgings.

Hill, Clarke & Co., 156-164 Oliver street, Boston, Mass., and 12-14 South Canal street, Chicago, Ill., have a very attractively arranged and printed catalogue of drilling and boring machines. A line of drills for all purposes is shown and the boring machines include the horizontal and vertical types. A few other machines such as planers and shapers are also listed, and the catalogue will be found convenient for reference by any one interested in machine tools.